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AMERICAN WATER WORKS ASSOCIATION

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CONTENTS

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All correspondence relating to the publication of papers should be addressed to Harry E. Jordan, Secretary, American Water Works Association, 29 West 39th Street, New York.

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Discussion of all papers is invited

Vol. 29 JANUARY, 1937 No. 1

AN APPRECIATION

With the December, 1936, issue Abel Wolman relinquished the Editorship of this JOURNAL. For almost sixteen years he has quietly and ably acted as the medium for organization of the papers and reports of this Association to the end that they appeared in the good form characteristic of this publication. The years have been busy for him and he has grown greatly in distinction among men of standing in national affairs.

Some of us have watched this development from year to year and have noted that, as his field of interest widened and as he met new problems, he still kept his rapier keenness of mind, his ability to measure relative values and his power to present his judgment clearly and effectively.

In no wise has his fundamental loyalty to the water works field and to this Association lessened.

He now puts aside his editorial work simply because his services in broader fields, particularly as a coördinator of the water resource activities of the Federal administration, demand his energy.

To him, the American Water Works Association and all technical men are infinitely indebted. He has done his work well. We who know him are certain that he will continue to do all things well.

1935–36 COLD WEATHER EXPERIENCES IN WISCONSIN

By Walter A. Peirce

(*Manager, Water Department, Racine, Wisconsin*)

A growing fatalism on the part of most of us led to a belief that "we never have old fashioned winters any more" but the season of 1935–1936 proved that "Old Man Winter" still had some vitality. February 1936 will particularly be remembered by Wisconsin Waterworks men as a time of stress marked by emergency calls, long hours of work and was another example of fidelity to the public interest. Many stories come to light of special effort to see that fire fighting facilities were not impaired and that customer's service was maintained as constantly as possible.

To form a basis for this discussion questionnaires were sent to 22 representative Wisconsin cities and a summary of the fifteen returned was made. Attention will be directed to the points on which practice differed or on which general agreement was observed, rather than to attempt a treatise on how to cope with cold weather.

An article by Fred Shepperd in Waterworks Engineering, May 30, 1934, gives a great deal of valuable information on electrical theory and methods. The Journal A. W. W. A. for July, 1936, Vol. 28, No. 7 contains several articles on thawing practices in general use and their practical application. A pipe thawing manual issued by the manufacturers of Hobart Welding Equipment contains much practical information, and gives details of various problems.

The southern part of the State won the race both as to lowest and highest percentage of active services frozen, Milwaukee reporting about one hundredth of one percent and Waukesha 6½ per cent, both cities reporting 6 foot service depth, but frost penetrating 6½ feet in Waukesha and only 5½ feet in Milwaukee. The tabulation shows that relative temperature of water leaving the plant influenced the number little, if any, frost penetration varying from 4 to 7½ feet being the determining factor. Minimum air temperatures ranged as low as 41° below zero.

Data is apparently not available as to whether the freezing oc-

THAWING SERVICE PIPES—WISCONSIN 1935–36

CITY	NUMBER	SERVICE DATA			FROST PENETRATION	MINIMUM AIR TEMPERATURE	HOW THAWED			DOES UTILITY REGULARLY MAINTAIN SERVICES?	
		Number active	Number frozen	Depth laid			Steam	Electricity	Other	Main to curb stop	Curb stop to meter
				feet							
Eau Claire	1	5,800	225	6–7	7½	−36	+	+		No	No
Fond du Lac	2	6,682	50	5–5½	4	−20	8	42		Yes	No
Green Bay	3	8,900	123	5	5½	−26		118	5 Hot water	Yes	No
Janesville	4	5,500	162	6	8	−29		+		Yes	No
Kenosha	5	11,762	500	5½	6	−27		+		Yes	No
La Crosse	6	8,875	100	6	5	−20		+		No	No
Madison	7	14,600	140	5–6	7	−30	1	139		Yes	No
Manitowoc	8	4,909	41	5½–6½				+		No	No
Menasha	9	1,950	72	5–6	6½	−33		+		Yes	No
Milwaukee	10	94,839	10	6	5½	−25		+		No	No
Racine	11	15,195	170	5½	6	−19		+		No	No
Sheboygan	12	9,495	50	6	5½	−21		+		No	No
Superior	13	8,055	109	6	6–7	−35		+		Yes	No
Waukesha	14	4,105	267	6	6½	−24	6	Yes		Yes	Yes
Wisconsin Rapids	15	2,019	45	6	7½	−41		+		No	No

CITY NUMBER	ELECTRICALLY THAW						REMOVE		COST OF THAWING				
	Generator	Transformer	A.C.	D.C.	Volts	Amperes	Meters	Electricity—ground	Per service	Borne by			
										Utility	Owner	Repeat calls	Water wasted
1											+		Owner
2		+	+		20	400	Yes	If necessary	24.05 3.08	+	5.00 Curb to meter	None	Utility
3		+	+		110–440	50–270	Yes	Yes	6.37	+		None	Utility
4	+		+	+	20+	100–600	No			+		0	Utility
5	+		+		2½	350	No		3.30	+		0	Utility
6	+			+	6	200	No		5.00		+	Owner	Owner
7	100	40	+	+	5–25	150–400	Yes	Yes	12.00	+		10.00	Utility
8		+	+		26–125	240–512	Yes	Yes	7.50		+	7.50	Owner
9		+	+		55	200–400	Yes	Yes		+			Utility
10		+	+		10–20	200–250	Yes	One	10.00	+		10.00	Utility
11	+	+	+		40–60	200–450	Yes	Yes	10.00	City wk.	Elec. wk.	Owner	Owner
12		+	+		110	200–300	Yes	No	7.50		+	Negot.	Utility
13		+	+		11–22	200–400	Most	Sometimes	5.50	2	107	3.00	Owner
14	+			+	20–50	200–500	Yes	Yes	4.70	+		Owner	Utility
15		+	+		Var.	50–600	No	No			+	None	Utility

curred between main and curb stops or between stop and meter—one city with 500 frozen services reported all between stop and meter while another gave their whole number (123) between main and curb.

Service material has no effect on freezing, the fact that more lead than iron or copper services were in trouble was of course due to more lead having been used.

Although steam and hot water were used in a few cases, electrical thawing is almost universal in use. This is not merely Wisconsin's pride in a method originated by a University of Wisconsin professor, but is due to the ease, efficiency and safety with which the work can be done. Six cities reported use of generators, about equally divided between A.C. machines especially designed for thawing, and D.C. machines originally intended for welding service. There might be some possibility of electrolysis trouble from use of D.C. under certain conditions, but nothing definite has been shown and should not occur if proper connections are made. Low voltage and high current values are safest, as well as best because heating values are greater. Manufacturers caution against using too heavy current with lead pipe due to danger of melting joints. Copper pipe, on account of its high conductivity, is generally more difficult to thaw. Current used varies generally from 200 to 400 amperes although cases are on record where 600 amperes was used.

The use of transformers requires more man power and is more cumbersome, although arrangements can usually be made with a power company to do the work. It is a more costly method due to more labor and longer time required to make connections.

The average time current flowed in thawing varied greatly, but from 10 to 30 minutes is about normal, although there is a record of 20 seconds as a minimum, and some report 1½ hours. In one instance a small transformer with 13 ampere input at 117 volts and output of 10 volts 83 amperes thawed a ¾-inch iron service in one hour.

Cost of electric thawing range from $2.70 to $12.00 per service, averaging about $6.15.

Most cities report that the cost of thawing is borne by the utility although some charge repeat calls to the consumers. About two-thirds of the cities reporting stated that the utility bore the cost of water allowed to waste to prevent freezing. This is good policy if the waste is under control in such a way that only those are authorized who have had freezing troubles. Promiscuous waste of water by all customers might dangerously increase demand.

The majority reported that meters and electrical grounds were removed before thawing was started. In view of some experiences elsewhere this is recommended practice.

In only one city were any odor or color troubles reported, and the work of the Departments was looked upon with favor by the consumers, especially when they learned the work would not cost them anything. In only three cities were the customers ordered to lower the services, but no statement was made as to whether lowering was done by the utility where regular service maintenance is part of their duty. In only one city does the utility maintain to the meter and only five of the fifteen require customers to maintain the entire service.

Troubles with mains were not so extensive due undoubtedly to continuous flow. Most of this thawing was done electrically although two cases were reported where it was left to nature, in both of which instances the main was ruptured. Generally speaking, mains thawed electrically were not broken.

Half of the cities reporting had no frozen hydrants and the number in other cities were small percentages of those in service. Thawing was generally by steam.

The great damage which may result from lack of water for fire protection due to frozen hydrants is responsible for the universal practice of fall inspection of all hydrants, pumping out all those not draining, and in some cases taking other precautions. One city placed manure around a number of them, while another "loaded them with alcohol." In the latter case it was not stated whether the hydrant caps were locked on, or whether the formula number was posted to prevent bootlegging.

Half of the cities reported no noticeable increase in pumpage. In two instances the risers of wash water tanks froze so that they were out of service for some time, but were thawed without damage. In one case a board and canvas enclosure was built and salamanders placed inside, and steam from a boiler forced into the riser.

The public favor produced when the consumer learns the thawing will not cost him anything (except as it is reflected in operating costs) is of interest. Also are experiences such as a utility in a nearby state had when water came out of the gas jets. In that case a service which was being thawed electrically was in contact with a gas pipe. Welding took place with an opening through the weld permitting water to enter the gas line.

DISCUSSION

MR. KURANZ, of Waukesha, stated that they had some concrete pipe in their distribution system which could not be thawed electrically and steam had to be used.

MR. SMITH, of Madison, stated that after services were thawed out the water was left running at one faucet to prevent the service again freezing. In spite of the fact that the customers were advised that no charge would be made for the water thus wasted, some of the takers closed the faucets with the result that the service again froze. In order to eliminate this condition the faucet washer in the faucet which was allowed to run, was actually cut so that the water could not be shut off without replacing the washer.

MR. BROWN of Eau Claire, stated that 23 percent of the hydrant leads were frozen and that they went down directly from the surface with a steam line, the steam line melting the frozen earth until the lead was encountered and then warming it up so that it could be thawed out.

(*Presented before the Wisconsin Section, October 6, 1936*).

LESSONS FROM THE WINTER OF 1935–1936

By W. C. Mabee

Chief Engineer, Indianapolis Water Company

The problems which beset many of the water plants in the United States during the early months of 1936 have added unforgettable experiences to the lives of water works men.

The Ohio and upper Mississippi valley cities were hard hit by the cold. Among them, Indianapolis experienced the coldest winter during the sixty-five years recorded by the local United States Weather Bureau. The normal onset of freezing weather is about December 18. The mean drops to 28°F. by the end of January and then returns to 32°F. by the end of the third week of February.

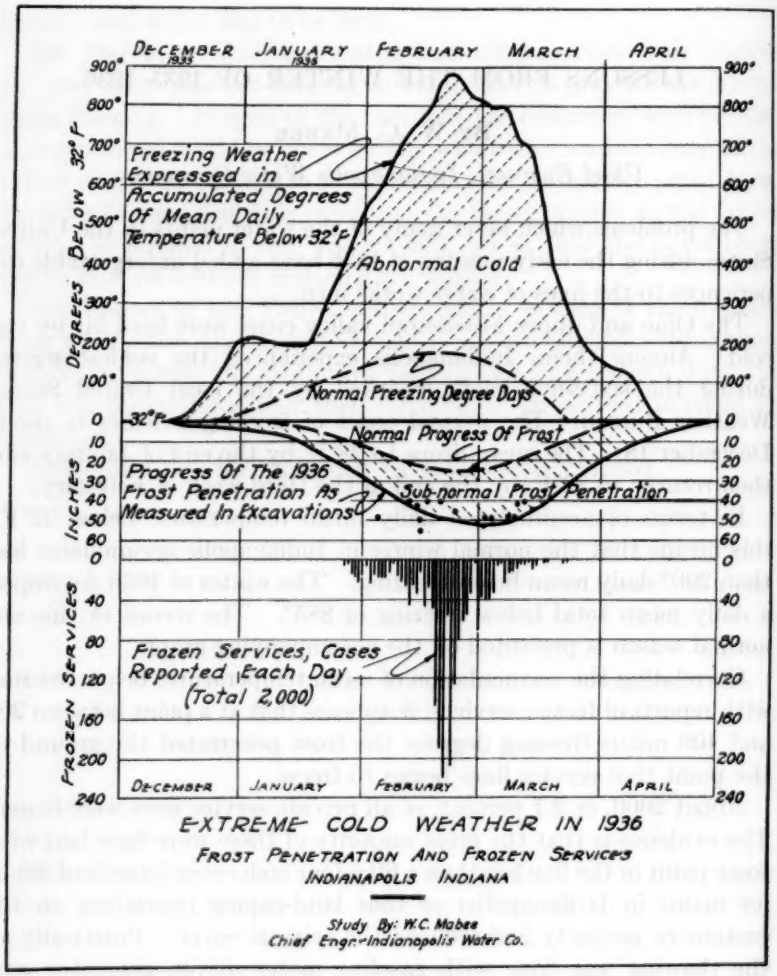
In terms of accumulated daily mean temperature below 32°F., this means that the normal winter in Indianapolis accumulates less than 200° daily mean below freezing. The winter of 1936 developed a daily mean total below freezing of 885°. The record of this abnormal season is presented on the accompanying graph.

Correlating the accumulation of mean temperatures below freezing with reports of frozen services, it appears that at a point between 200 and 400 minus freezing degrees the frost penetrated the ground to the point that service lines began to freeze.

About 2000, or 2.7 percent, of all private service lines were frozen. The evidence is that the great majority of these were lines laid with some point in the line less than a fifty-four inch cover (standard depth for mains in Indianapolis) or that landscaping operations on the customers' property had reduced the original cover. Practically all the thawing was done with gasoline motor driven generator sets. The most satisfactory current condition was at 40 volts with a delivery of 300 amperes. An average of from fifteen to twenty minutes current application was required to thaw a service.

It appears that, by a correlation of the total below freezing degrees with last winter's onset of unusual freezing troubles, water department superintendents can become prophets in their own behalf.

A day to day record of below freezing days can be developed as each winter progresses. When the total approaches that at which trouble



developed, the superintendent can again prepare for the emergency duties which kept him busy in the winter of 1935–1936.

FLUORIDE IN OHIO WATER SUPPLIES—ITS EFFECT, OCCURRENCE AND REDUCTION

By R. D. Scott,[1] A. E. Kimberly,[2] A. L. Van Horn,[3] L. F. Ey[4] and F. H. Waring[5]

Toxic qualities of fluoride in water used for drinking and cooking during the period of teeth calcification cause what is commonly known as "mottled enamel" or specifically as chronic endemic dental fluorosis. This condition has been observed in approximately 300 areas, distributed among 23 states of the Union and, as reported by Dean (1), confirmed in excess of 200 such areas. Sixteen of these states are west of the Mississippi River.

Hitherto water-borne diseases of endemic proportions have been considered due to pathogenic bacteria or other organisms. Through investigations and research, beginning in 1926, however, it is now established that the element fluorine combined as a fluoride, when present in a water supply, in excess of about 1.0 p.p.m. affects the teeth of growing children and thus a relatively new problem has arisen in the water supply field.

Ordinarily, fluoride in toxic concentration is generally found only in underground water supplies and, therefore, from the public water supply standpoint, the problem is confined to the smaller communities, although it is appreciated that in some states relatively large population centers depend upon such supplies.

HISTORICAL

Apparently, the first record (2) of mottled enamel was made at Naples, Italy in 1901, by Surgeon J. M. Eager of the U. S. Public Health Service who noted this condition in the teeth of emigrants.

In this country, F. S. McKay and C. V. Black (3) made the first

[1] R. D. Scott, Chief Chemist, Ohio Department of Health.
[2] A. E. Kimberly, Engineer, P.W.A. in Ohio.
[3] A. L. Van Horn, M.D., Chief, Bureau Child Hygiene, Ohio Department of Health.
[4] L. F. Ey, Director of Laboratories, Ohio Department of Health.
[5] F. H. Waring, Chief, Division of Engineering, Ohio Dept. of Health.

recorded observations in 1916. The first definite recognition of the relation of water to mottled enamel was given by McKay (4) in 1926.

Oakley, Idaho (5) in 1925 and Bauxite, Arkansas (6) in 1930 were forced to develop new water supplies because of endemic mottled enamel.

The fact that fluorides in drinking water are the cause of this dental defect was first definitely correlated by Smith, Smith and Lantz (7) in 1931.

The seriousness of the situation is further shown by the fact that this year a suit for damages was filed against the Village of Chetopa, Kansas, alleging responsibility for mottled enamel, due to the presence of fluoride in the municipal water supply.

The fluoride problem was not recognized as existing in Ohio until 1935. Beginning February 1, 1935, however, fluoride has been included as a routine determination in the laboratories of the Ohio Department of Health.

MOTTLED ENAMEL

Mottled enamel, a term first used by Black (8), appears as a brown or yellow stain, at times absolutely black or in other cases, as a ghastly opaque white. The condition is readily noted when the lips are open.

This dental defect has been noted in England, Holland, Italy, North Africa, Mexico, Spain, China, Japan and in several South American countries. There is no race, color or sex differential.

In endemic areas, the severity of the disease is determined by the examination of the teeth of children in the fourth to eighth grades, inclusive. The condition of the enamel is recorded under seven classifications, ranging from normal to severe. In the last class, the teeth show marked black discoloration, deep confluent pitting, and ultimate complete destruction.

Clinical surveys have been made during 1936 in five different Ohio communities known to have water supplies which contain in excess of 1.0 p.p.m. fluoride.

The results of these surveys are shown in table 1. It will be noted that the range in positive cases under continuous residence is between 20 and 72 percent.

The maximum degree of mottling in Ohio, as shown by these surveys, is "moderate" or "moderately severe." In no case has "severe" mottling been noted. The situation in Ohio is not so seri-

ous as in certain western states, but the fact cannot be ignored that a large number of children in certain endemic areas in Ohio are suffering from permanent defects of the teeth, due to the presence of fluorine in the public water supply.

PREVALENCE

As of September 1, 1936, well waters from 49 localities in Ohio, most of which are municipal supplies, existing or proposed, have been found to contain over 1.0 p.p.m. fluoride. Seventeen such supplies contain 2.0 p.p.m. or more and three 3.0 p.p.m. or more. To date, the maximum concentration of fluoride was found in a Stark County well which contains 4.0 p.p.m. A well water proposed for use as a public water supply for New Washington, Crawford County, was found, on analysis, to contain 3.6 p.p.m. fluoride.

TABLE 1

Incidence of mottled enamel among grade school children in selected Ohio communities

COMMUNITY	FLUORIDE (F)	CONTINUOUS RESIDENCE SINCE BIRTH			NON-RESIDENT		
		Examined	Affected	Per cent affected	Examined	Affected	Per cent affected
	p.p.m.						
A	2.4	211	50	23	118	8	6
B	2.1–2.6	105	21	20			
C	1.4	44	17	38	156	31	19
D	2.6	44	10	22			
E	2.6	29	21	72	73	22	30

Although incomplete, a survey of Ohio ground waters indicates that most of the well waters of high fluoride content are located in the northwest section of the state and in a smaller area southwest from Columbus to Wilmington. In Ohio, generally speaking, ground water containing high fluoride is obtained from the Niagara limestone, but occasionally in gravel wells where shale lies above or below the water bearing gravel.

Range in fluoride concentration

Wells in a given locality contain different quantities of fluoride, so that it may be possible by thorough prospecting to select an underground supply with minimum fluoride, obviously most advantageous

from health and economic standpoints. This fact is indicated by the analytical data in table 2.

Relation to source of supply

Indicative of the fact that supplies from limestone formations generally contain relatively high fluorides, note the data in tables 3 and 4 covering new municipal water supplies recently installed under PWA financing. It will be observed that the controlling factor is the type of aquifer and not the depth of the well.

Analytical procedure

Earlier methods of analysis made by evaporation, distillation, treatment of residue with sulphuric acid and titration of the evolved

TABLE 2

Variation of fluoride content of well waters in a given area

	FLUORIDE	
	Maximum	Minimum
	p.p.m.	*p.p.m.*
8 wells, vicinity of Baltimore, Fairfield Co.	2.4	0.7
11 wells, vicinity of Bloomdale, Wood Co.	2.6	0.95
6 wells, vicinity of New Washington, Crawford Co.	3.6	1.0
21 wells, vicinity of Alger, Hardin Co.	3.0	0.6

silicon tetrafluoride, gave only approximations. Similarly, the Fairchild method or its modifications gave results two or three times too high, a fact which explains the high fluoride results noted in the earlier literature.

Preferred methods are based upon the zirconium alizarine method of DeBoer, as modified by Sanchis (9) and by Elvove (10), whose procedure has been adopted as official and is presented in detail in the 8th (1936) edition of Standard Methods of Water Analysis.

The Ohio Department of Health laboratories follow the Sanchis procedure with the following slight modifications:

1. Referring to the original paper, the two acid solutions are combined.
2. 0.1 mgm. F in 100 cc. is about the limiting amount for a good color distinction.

TABLE 3

Engineering and analytical data on representative well supplies showing geographical distribution of fluorine

MUNICIPALITY	COUNTY	1930 POPULATION	AQUIFER	DEPTH OF WELL	ANALYSIS OF WATER						
					Total solids	Alkalinity	Incrustants	Total hardness	Fluoride	Iron	Alkaline carbonates
Northwest											
				feet	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*
Arlington	Hancock	701	Limestone	75	868	364	213	577	2.0	0.4	0
Bloomdale	Wood	578	Limestone	185	1,792	110	915	1,025	2.6	0.15	0
Fayette	Fulton	847	Gravel	200	349	275	9	284	0.7	1.3	0
McComb	Hancock	932	Limestone	87	1,140	80	433	513	1.2	0.1	0
Mt. Victory	Hardin	597	Limestone	144	644	318	131	449	2.4	0.9	0
N. Baltimore	Wood	2,402	Limestone	125/145	1,580	258	509	767	1.4	0.10	0
Pemberville	Wood	960	Limestone	150/200	680	218	178	396	1.6	0.4	0
Sherwood	Defiance	521	Sand and gravel	91	430	250	0	235	1.0	0.3	15
Stryker	Williams	817	Sand and gravel	137	566	275	0	231	1.1	0.9	44
Walbridge	Wood	905	Limestone	325	816	120	380	500	2.6	0.2	0
Northeast											
Butler	Richland	634	Sand rock	146	330	108	0	107	0.1	0.23	1
Canfield	Mahoning	1,015	Sand	174/452	540	410	0	79	0.8	0.8	331
Creston	Wayne	1,029	Sand and gravel	120	316	218	0	163	0.5	1.0	55
East Canton	Stark	962	Sandstone	262	402	205	85	290	0.3	0.5	0
Jeromeville	Ashland	403	Gravel	185	495	285	51	336	0.2	1.1	0
Perrysville	Ashland	615	Sand and gravel	185	300	228	36	264	0.15	0.25	0
Seville	Medina	785	Sand-shale	162	622	280	0	147	0.6	1.8	133
Shiloh	Richland	514	Sand and gravel	97	470	293	65	358	0.3	0.8	0

TABLE 4

Engineering and analytical data on representative well supplies showing geographical distribution of fluorine

MUNICIPALITY	COUNTY	1930 POPULATION	AQUIFER	DEPTH OF WELL	ANALYSIS OF WATER						
					Total solids	Alkalinity	Incrustants	Total hardness	Fluoride	Iron	Alkaline carbonates
Southwest											
				feet	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*	*p.p.m.*
Camden	Preble	888	Sand and gravel	51	371	275	41	316	0.1	0.05	0
Fletcher	Miami	407	Limestone	182	317	268	0	237	0.85	0.6	31
Jackson Center	Shelby	526	Limestone	100	362	315	0	315	0.6	1.4	0
Nevada	Wyandot	741	Limestone	93	792	411	210	621	1.2	1.2	0
New Carlisle	Clark	1,089	Gravel	40	446	283	70	353	0	0.10	0
New Madison	Darke	516	Limestone	110	406	345	18	363	0.4	3.4	0
Russel Point	Logan	344	Gravel	94	680	211	198	409	1.2	0.7	0
Tippecanoe City	Miami	2,559	Gravel	85	340	263	28	291	0	0.1	0
Union City	Darke	1,305	Sand and gravel	85	488	340	0	325	1.0	1.7	15
Southeast											
Baltimore	Fairfield	720	Sand and gravel	167/181	356	265	0	229	2.1	0.7	36
Byesville	Guernsey	2,638	Sand and gravel	43	240	214	0	195	0.2	5.0	19
Danville	Knox	764	Sandstone	150	243	189	18	207	0.15	0.3	0
Flushing	Belmont	1,119	Gravel	60/94	323	250	19	269	0.2	0.2	0
Groveport	Franklin	946	Gravel	95	410	355	10	365	0.2	2.0	0
Gnadenhutten	Tuscarawas	870	Sand and gravel	84	396	135	98	233	0.1	0.2	0
Holloway	Belmont	772	Sand and gravel	79	464	236	0	161	0.3	0.5	75
McArthur	Vinton	1,188	Sandstone	250/262	609	224	0	68	0.3	0.2	156
Oak Hill	Jackson	1,578	Fine sand	42	249	128	12	140	0	0.10	0
Taylorsville	Muskingum	804	Sand and gravel	76	806	198	313	511	0.3	0.1	0
Smithfield	Jefferson	1,023	Sandstone	70	440	275	0	272	0.3	0.3	3

3. If the sulphate, SO_4 concentration is as much as 250 p.p.m. in the tube as read, corrections are applied:

250 p.p.m. SO_4 0.02 p.p.m. apparent fluoride, F
300 p.p.m. SO_4 0.05 p.p.m. apparent fluoride, F
400 p.p.m. SO_4 0.10 p.p.m. apparent fluoride, F
500 p.p.m. SO_4 0.15 p.p.m. apparent fluoride, F
700 p.p.m. SO_4 0.20 p.p.m. apparent fluoride, F

METHODS OF REMOVAL

A number of studies have been made to develop methods for the reduction or the removal of fluorides in view of the fact that, in many localities, underground waters containing toxic concentrations of fluoride are the only sources of public water supply. The problem is obviously of marked importance in its social and economic aspects.

Earlier investigations

Apparently the first recorded efforts to investigate a method for removing or reducing fluoride is the work of C. S. Boruff (11) of the State Water Survey of Illinois. These studies included the use of aluminum sulphate, sodium aluminate, zeolite, activated alumina and bauxite.

In concentrations between 2.0 and 3.0 p.p.m., the application of 2 grams per gallon of sulphate of alumina reduced the fluoride to 1.0 p.p.m. Sodium aluminate, zeolite, silica gel, sodium silicate and ferric salts were not effective.

Boruff points out that the addition of calcium hydroxide effects a substantial reduction of fluoride, but no mention is made of the relation of the magnesium concentration to the results obtainable by lime treatment, the important conclusion which Scott has drawn from his recent researches.

McKee and Johnston (12) of Columbia University have shown that even with fluoride concentrations as high as 7.5 p.p.m. excellent reductions are obtainable by the use of activated carbon. Unfortunately, the success of this treatment depends upon the reduction of the pH to 3.0 or below.

Fluoride removal by lime treatment

In the spring of 1935, incident to the routine examination of raw and treated municipal water supplies, Scott noted that the fluoride concentration in the effluents from lime softening plants show a substantial reduction as compared to the fluoride in the raw water. No reduction, however, was noted in zeolite softened water.

Experimental

With a view to verifying the above observations, bottle tests were made, using natural waters with and without the addition of graded quantities of sodium fluoride. The tests show a reduction of fluoride by lime and also the important fact that the degree of reduction is a function of the removal of magnesium. Apparently fluoride is adsorbed by the gelatinous magnesium hydroxide precipitate.

TABLE 5

Results of bottle experiments on fluoride removal by lime softening

MAGNESIUM REMOVED	FLUORIDE			
	Initial	Residual	Removed	Calculated removal
	p.p.m.	*p.p.m.*	*p.p.m.*	*p.p.m.*
88	3.0	1.1	1.9	2.0
45	3.0	1.4	1.6	1.4
38	3.0	1.6	1.4	1.3
17	3.0	1.8	1.2	0.9
13	3.0	2.2	0.8	0.8
85	10.0	5.0	5.0	6.4
85	5.0	2.0	3.0	3.2
85	3.0	1.1	1.9	1.9
85	1.9	0.6	1.3	1.2
65	3.4	1.1	2.3	1.9
38	3.4	1.6	1.8	1.5
15	3.4	2.3	1.1	0.9
27	10.0	7.5	2.5	3.6
27	5.0	3.6	1.4	1.8
27	3.0	1.8	1.2	1.1
27	1.9	1.2	0.7	0.7
97	2.4	0.8	1.6	1.6
28	2.4	1.3	1.1	0.9
46	1.4	0.6	0.8	0.7
100	3.0	1.0	2.0	2.1

From a study of the summarized results next presented, it will be noted that there is indicated a definite relation between magnesium and fluoride reduction. This relation, which appears to hold between initial fluoride concentrations of from 1.5 to 3.5 p.p.m., is that the fluoride reduction is approximately equal to 7 percent of the initial fluoride multiplied by the square root of the magnesium removed.

In terms of residual fluoride, the equation is:

$$Y = F - (0.07\,F \times \sqrt{X})$$

where Y = Residual fluoride
F = Initial fluoride
X = Magnesium (Mg) Removed

Table 5 presents the experimental data from which the above equation was deduced.

Table 6 shows the quantity of magnesium (Mg) that must be removed to secure residual fluoride concentrations of 1.0 p.p.m. when the initial fluoride is between 3.5 and 1.5 p.p.m.

TABLE 6

Magnesium removal in relation to an effluent fluoride concentration of 1.0 p.p.m. and initial fluoride concentration ranges from 3.5 to 1.5 p.p.m.

FLUORIDE		MAGNESIUM REMOVED
Initial	Residual	
p.p.m.	*p.p.m.*	*p.p.m.*
3.5	1.0	146
3.0	1.0	91
2.5	1.0	73
2.0	1.0	51
1.5	1.0	23

Discussion

To effect a high percentage removal of magnesium, essential to secure proper fluoride reduction, necessitates adding sufficient lime to raise the pH to around 10.5. Under these conditions, a caustic alkalinity of about 30 p.p.m. is required. Such over treatment is, of course, corrected by carbonation.

The lime dosage must obviously correspond to the free and half-bound carbonic acid, the magnesium and the necessary causticity.

Since magnesium concentrations of 150 p.p.m. are rarely found in Ohio ground waters, fluoride reduction by lime treatment without the addition of magnesium salts is not practical beyond a fluoride concentration of 3.5 p.p.m. In general, the magnesium in Ohio ground waters averages only about 40 p.p.m. On an average basis, the concentration of magnesium in Ohio well waters may be estimated as 9 percent of the total hardness.

On the basis of the fluoride reduction formula, it is evident that a magnesium removal of 100 p.p.m., secured, if necessary, by the addition of a magnesium salt, limits the initial fluoride content to 3.3 p.p.m., if the residual concentration is to be 1.0 p.p.m. On economic grounds, every effort should be made to secure a water supply of lower fluoride content, in case waters of high fluoride concentration are encountered.

TABLE 7

Fluoride removal by sulphate of alumina

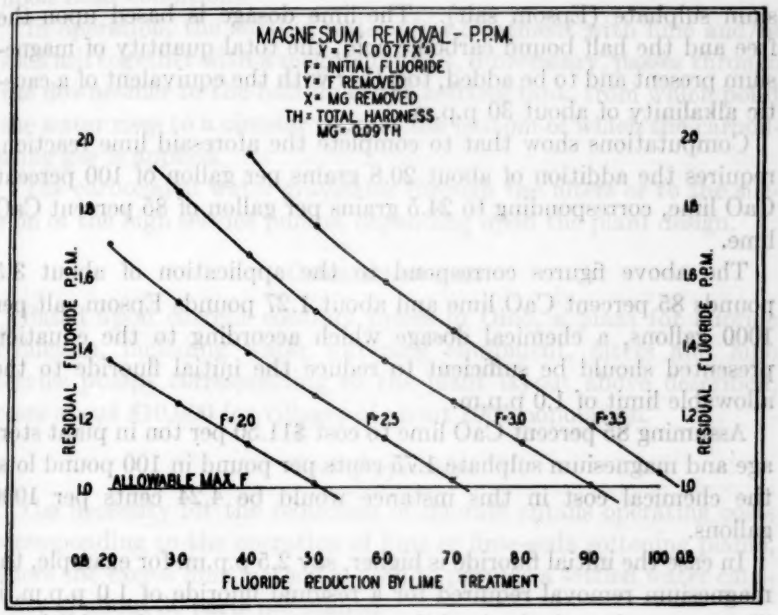
ALUMINUM ULPHATE	FLUORIDE*	ALKALINITY	pH
grains per gallon	*p.p.m.*	*p.p.m.*	
0	1.7	312	7.2
2	1.6	300	7.0
5	1.4	275	6.8
10	1.1	238	6.6
15	0.8	204	6.5
20	0.6	168	6.3
30	0.4	105	6.2
0	3.0	290	7.8
2	2.6	278	7.5
5	2.2	262	7.2
10	1.7	232	6.9
20	1.0	165	6.5
0	6.0	308	7.5
2	5.4	298	7.2
5	4.5	278	7.0
10	3.5	240	6.8
20	2.4	168	6.5
30	1.9	105	5.8
40	1.5	50	5.6

* Residual.

Fluoride reduction by aluminum sulphate

A well water containing as collected 1.7 p.p.m. F was treated with graded amounts of alum (C. P. aluminum sulphate 16.56 per cent, Al_2O_3), after adding sodium fluoride to produce initial concentrations also of 3.0 and 6.0 p.p.m. F. One liter portions contained in one liter Pyrex Erlenmeyer flasks were kept tightly stoppered and were shaken at least 10 times daily for 7 days, then let stand over night and the clear supernatant was decanted off and examined.

The results, as shown in table 7, indicate that initial fluoride concentrations of 1.7, 3.0 and 6.0 p.p.m., respectively, may be lowered to 1.0 p.p.m. by corresponding alum dosages of 11.5, 20.0 and 52.0 grains per gallon. Following alum treatment, presumably lime or soda would be added to prevent corrosion troubles. One grain per gallon alum would require about 0.33 grain per gallon of 85 per cent CaO or 1.06 grain per gallon soda ash.



It should be noted that Boruff obtained greater proportionate fluoride removal by similar treatment. In his studies, initial fluoride of 1.5, 3.0 and 5.0 p.p.m. was reduced to 1.0 p.p.m. by sulphate of alumina dosages of 1.3, 2.3 and 10.0 grains per gallon, respectively.

Rôle of magnesium

In further illustration of the rôle of magnesium in relation to the reduction of fluoride by lime treatment, graphs of the above equation have been prepared covering initial fluoride concentrations ranging from 2.0 to 3.5 p.p.m.

On the graph the ordinates represent the quantity of residual

fluoride and the abscissae the magnesium removal, all data in parts per million.

Assume a water with the following analysis in parts per million: Total hardness, 400; alkalinity, 300; free carbonic acid, 40; magnesium (Mg), 36; fluoride (F), 2. Referring to the graph, it will be noted that 51 p.p.m. magnesium must be removed to reduce the fluoride from 2.0 to 1.0 p.p.m. It would in this case be necessary to add to the raw water 15 p.p.m. magnesium or 152 p.p.m. magnesium sulphate (Epsom salt). The lime dosage is based upon the free and the half bound carbonic acid, the total quantity of magnesium present and to be added, together with the equivalent of a caustic alkalinity of about 30 p.p.m.

Computations show that to complete the aforesaid lime reaction, requires the addition of about 20.8 grains per gallon of 100 percent CaO lime, corresponding to 24.5 grains per gallon of 85 percent CaO lime.

The above figures correspond to the application of about 3.5 pounds 85 percent CaO lime and about 1.27 pounds Epsom salt per 1000 gallons, a chemical dosage which according to the equation presented should be sufficient to reduce the initial fluoride to the allowable limit of 1.0 p.p.m.

Assuming 85 percent CaO lime to cost $11.50 per ton in plant storage and magnesium sulphate 1.75 cents per pound in 100 pound lots, the chemical cost in this instance would be 4.24 cents per 1000 gallons.

In case the initial fluoride is higher, say 2.5 p.p.m. for example, the magnesium removal required for a residual fluoride of 1.0 p.p.m. is 73 p.p.m. and on the basis of the assumed raw water, the addition of 37 p.p.m. magnesium is required or 375 p.p.m. Epsom salt. Under such conditions the chemical cost, based upon the assumed unit prices, is about 7.79 cents per 1000 gallons.

PRACTICAL ASPECTS AND COSTS

The practical application of lime treatment for the reduction of fluoride is discussed under the following headings: Type of Plant; Construction Costs; Cost of Operation; and operating results from typical Ohio plants, some of which have recently been installed.

Type of plant

The usual standard type of water softening plant is obviously adapted to fluoride reduction problems. In the smaller plants,

the design usually corresponds to that used in railroad softening practice and generally includes: (*a*) aerator; (*b*) settling and reaction tank with provisions for the application of the softening chemicals at the top of the downcomer, ordinarily equipped with adequate mixing devices; (*c*) provisions for recarbonating; (*d*) pressure or gravity filters with high service pumps, perhaps more satisfactorily taking suction from the filters, although the detailed design is dependent upon head conditions.

In operation, the aerated water after treatment with lime and/or soda ash together with a magnesium salt, if necessary, passes through the downcomer to the bottom of the settling tank, from which point the water rises to a circular weir, at the bottom of which the carbonating gas is applied.

The carbonated water gravitates through the filters or to the suction of the high service pumps, depending upon the plant design.

Construction costs

Based upon current contract prices in Ohio, a plant for fluoride reduction, including water softening equipment, filters and high service pumps corresponding to the plant layout above described, costs about $10,000 for villages of about 1000 population.

Cost of operation

The necessity for the reduction of fluoride entails operating costs corresponding to the operation of lime or lime-soda softening plants, where the excess lime method is used to provide a settled water causticity of about 30 parts per million.

As previously discussed, under certain conditions, to effect a reduction of fluoride to 1.0 p.p.m. requires the addition of a magnesium salt. In such cases, the operating cost of softening plants, designed to reduce fluoride to safe limits, is increased by the added cost of the required magnesium addition to the chemical dosage.

Based upon present information, magnesium sulphate is the only practical commercial source of soluble magnesium, the use of which entails a cost of about 17.7 cents per pound for each pound of magnesium (Mg) added.

On the basis of the assumptions made as to the composition of a raw water containing 2.0 p.p.m. fluoride (F) and 36 p.p.m. magnesium, the cost of fluoride reduction including the added magnesium, corresponds to a total chemical cost of about 4.24 cents per 1000 gallons. The magnesium cost is about 2.23 cents per 1000 gallons,

which plus 0.2 cent for the additional lime required to react with the added magnesium, or 2.43 cents, represents the additional cost of operation of a plant for fluoride reduction over and above that required for water softening alone. Again assuming raw water of the same composition as above, but containing 2.5 p.p.m. fluoride, the additional cost of the treatment based upon the addition of magnesium and the additional lime is 5.98 cents per 1000 gallons.

It is evident that with lime treatment, the cost of fluoride removal is high where relatively large quantities of fluoride are present, because of the relatively high cost of the required addition of a magnesium salt. Should the supply be soft, thus necessitating the addition of substantial quantities of magnesium, the treatment becomes impracticable on economic grounds and every effort should be made to secure a new source of supply.

Chemical control

The operation of a fluoride reduction plant, as in any softening plant, should be placed under skilled technical supervision, especially during the early months of operation, with a view to making any required adjustments of the applied chemical. Ordinarily, both the fluoride and hardness in the raw water will fluctuate but slowly, so that if the proper procedure is once developed, periodic visits by a supervising chemist should be sufficient. In other words, the cost of the technical supervision at a plant which includes fluoride reduction, should not exceed that required in the case of ordinary softening plants which operate on ground water.

FLUORIDE REDUCTION IN PRACTICE

During 1936, lime softening plants aided by Public Works Administration financing have been built in Ohio at Alger, Hardin County; Baltimore, Fairfield County; and Mt. Sterling, Madison County, with respective populations of 857, 720 and 1090. The plant at Baltimore also furnishes the supply to the contiguous village of Basil with a population of 716.

Analytical data available from these three plants are presented in table 8. The Baltimore plant has just been placed in service and although as evident, the treatment has not been finally adjusted, yet the results are presented as illustrative of the important rôle of magnesium in the reduction of fluoride.

Alger

The fluoride in the raw water at Alger is 1.5 p.p.m. and is reduced to 0.7 p.p.m. with a corresponding removal of 32 p.p.m. magnesium. On the basis of the previously stated formula, residual fluoride is 0.9 p.p.m. It is obvious that this plant effectively reduces the fluoride to safe limits. It is also important to observe that this raw water contains sufficient magnesium to satisfy the fluoride reduction requirements, so that the addition of a magnesium salt is not necessary.

Baltimore

At Baltimore as of November 9, 1936, the 2.1 p.p.m. fluoride in the raw water was reduced only to 1.6 p.p.m. Referring to the chart

TABLE 8

Fluoride reduction at Ohio lime and/or lime-soda softening plants

SOURCE	ALGER		BALTIMORE		MT. STERLING	
	Raw	Eff.	Raw	Eff.	Raw	Eff.
Fluoride	1.5	0.7	2.1	1.6	1.7	0.95
Magnesium	46	14	23	9	42.7	16
Total hardness	523	121	234	65	449	99
Alkalinity	337	42	270	101	373	88
Incrustants	186	79	0	0	76	11
pH	7.8	10.4	7.7	10.0	7.1	10.1

and on the basis of this formula, in order to reduce the initial fluoride to 1.0 p.p.m., requires the removal of 56 p.p.m. magnesium. In other words, it is necessary to include a magnesium salt in the chemical dosage, since the initial magnesium content is only 23 p.p.m.

With a view to securing the desired removal of fluoride at Baltimore, consideration is being given to modifying the treatment by the addition of 38 p.p.m. magnesium, which in the form of magnesium sulphate requires the addition of 3.22 pounds per 1000 gallons. The Baltimore data appeared most instructive as a verification of the conclusion that fluoride reduction varies as a function of the removal of magnesium and that unless the proper quantity of magnesium is present in the raw water, the deficiency must be supplied by the addition of a magnesium salt.

Mt. Sterling

At Mt. Sterling, lime treatment reduces the 1.7 p.p.m. fluoride in the raw water to 0.95 p.p.m. and the magnesium from 42.7 to 16.0 p.p.m. Theoretically, the calculated reduction of fluoride corresponding to the foregoing removal of magnesium is 0.6 p.p.m., or to a residual of 1.1 p.p.m., again closely agreeing with actual results in practice.

CONCLUSIONS

Mottled enamel in mild form is endemic in Ohio, particularly in counties in the northwest section of the state. In a number of other states, the situation is far more serious.

It has been definitely shown that this dental defect is due to the presence of fluoride in the water used for cooking and drinking and that mottled enamel may be expected to develop if the water contains more than about 1.0 p.p.m. fluoride. The problem is relatively new in the water works field.

Recent studies by one of the authors indicate that by over treatment with lime to a causticity of about 2 grains per gallon, in the presence of sufficient magnesium, between the limits of 1.5 and 3.5 p.p.m. fluoride, the residual fluoride in the treated water is reduced to 1.0 p.p.m. The removal of fluoride in the above process varies as the square root of the removal of magnesium. Under certain conditions in the presence of relatively high fluoride, the addition of a soluble magnesium salt is necessary.

With practically no modification, water softening plants of the standard type are adaptable to fluoride reduction problems. Ordinarily, only the relatively small municipality is concerned with the removal of fluoride, inasmuch as the surface supplies of the larger population centers rarely contain fluoride in toxic quantities. In many instances the situation is reversed in the smaller communities which perforce depend upon wells for water supply.

For villages with a population of 1000, the construction cost of a lime softening-fluoride reduction plant is about $10,000.

Operating costs correspond to those of a standard water softening plant, increased, however, if the character of the raw water is such as to require the addition of magnesium to effect a sufficient reduction of fluoride. Initial operation should be entrusted to a skilled chemist, but when a proper chemical dosage has been developed, no greater

attention is required where fluoride reduction is important, than is necessary at the ordinary lime or lime-soda water softening plant.

Operating results at the existing water softening plants at Marion and Mt. Sterling and the recently installed plants at Alger and Baltimore (Ohio) confirm our conclusions as to the efficiency of excess lime in reduction of fluoride content.

The problem of fluoride reduction, while relatively new in the water works field, is of great importance in many sections of the country and under no circumstances should a well supply be considered as a source of public water supply until definite knowledge is available as to its fluoride content.

Fluoride problems require for solution the coöperative efforts of the dentist, the chemist, and the water works engineer.

(Presented at the sixteenth annual Ohio conference on water purification, Columbus, Ohio, September 29, 1936.)

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THE PROPER MAINTENANCE OF A WATER DISTRIBUTION SYSTEM

By James S. Dunwoody

(*Superintendent, Water Department, Erie, Pennsylvania*)

In the operation of a present day water works there are many steps in the delivery of a satisfactory product to the consumer. If we give consideration to the major subdivisions of an active water plant, we find the following steps which call for constant attention;—water collection, purification, pumping, distribution, billing and collection. There are many subdivisions of these principal operations, and problems without number develop to trouble the plant superintendent.

The wide variation in sources of supply, quality of water, topography of the ground of the community being served, availability of power, or one of many other reasons intensifies or tends to minimize certain of these operating features for every plant manager.

The city that is fortunate enough to have its water supply located on an elevated area eliminates pumping by the use of gravity feed; the city with an uncontaminated supply will not require purification; while the city located on a large body of fresh water does not have to give serious consideration to water collection.

There is, however, one function of a water works which is of equal importance to all superintendents, and that is distribution. Regardless of the source or quality of a water supply its distribution is much the same in all communities.

Distribution systems usually originate to take care of small communities, and because of the simplicity of the existing requirements are quite often laid out with little thought of future developments. Eliminating from the problem of distribution the condition which is created by the topography of the land on which a system is built, I venture to state that there is not a single established water works which does not have certain areas of its distribution system delivering below the requirements of the National Board of Fire Underwriters for adequate fire protection. The reason for this in the great ma-

jority of cases can be traced to the laying of small mains at some time in the past without thought of future requirements.

THE VALUE OF PLANNING

Any well developed system of distribution, regardless of size, should be built and developed from a plan created by survey and careful lay-out.

Consideration has to be given to but one requirement to assure a successful system for the distribution of water, and that is adequate fire protection. If this one item is kept carefully in mind, and a lay-out made to properly meet this need, you can be assured of a system sufficient for all other demands.

Life's embarrassing moment for a water works superintendent is to have the fire chief report the loss of a building by fire because of insufficient water.

In making a distribution system survey, careful consideration should be given to the locations and growth of mercantile, industrial and residential areas, and the layout should be made of sufficient capacity to take care of the maximum fire demand for each type of land occupancy as far into the future as is consistant with the sound investment of funds. There are very few cities today which can be charged with the careless investment of money in water mains of too great a size to meet the needs, and I for one would be hard to convince on such a score, especially if future growth could be clearly forecast which would require such an expenditure to insure adequate service.

A water line is a revenue producer from the minute it goes into service, and the volume of revenue usually increases with the years. If a line when once installed can remain a growing revenue producer without the expense of reënforcing, the soundness of an adequate original investment is appealing. Furthermore, the cost of projecting a booster main into a district is usually exceedingly expensive. The area is most certain to be conjested with other utilities, the streets paved, and in every other way set up to make for slow and expensive construction.

RECORD MAPS ESSENTIAL

Whenever a lay-out for water main extensions has been completed on the basis of sound engineering, having given full consideration to future growth, a map or series of maps should be prepared covering

the entire area to be served. A strict adherence to the lay-out should be followed, and no mains laid unless they are equal to the sizes shown.

It has been some time since the larger cities have laid anything less than 6-inch mains in distribution systems, and there is no justifiable reason why the small communities today should install smaller sizes. The difference in cost is negligible, and there is immediately eliminated a fire flow restriction which falls under the minimum requirements of adequate protection. Two additional difficulties are established when mains smaller than 6 inches are laid; insurance rate penalty, and no provision for growth.

The importance of completely griding a system hardly needs comment as this has long been recognized as the best construction. Nevertheless, it is safe to assume that there are many important systems in operation today with numerous incompleted grids which could be completed by the laying of a few feet of pipe. A periodic survey of a distribution system is recommended to reveal this and other weaknesses which develop unsuspectedly.

VALVES MUST BE MAINTAINED

Much could be said about the valve lay-out of a well designed distribution system, but this I shall omit. I do wish, however, to take this opportunity to call your particular attention to the maintenance of valves. The standards of quality adopted for water main construction today often permits of years of continuous service without the need of repairs, and because of this we are apt to pay little or no attention to a street main until trouble is reported. The first thing that comes into active use after the trouble has developed is the valve. If these have not been properly maintained we are apt to find it impossible to obtain a tight shut down, or possibly find it necessary to force a valve because of accumulated corrosion, thereby springing the stem and rendering the valve useless.

Regardless of the fact that we are building our valves bronze to bronze at all contacting parts, there are still plenty of opportunities for corrosion to develop in the vicinity of the moving parts to such an extent that the valve can be of little or no service when needed.

All valves should be inspected and operated at least once a year to insure successful service. Particular attention should be given to the type of packing used in valves, and all valves in pits (this of course refers principally to large units) should be lubricated at

regular intervals. All spur and beveled gearing should be packed in grease and protected from street dirt.

I have tried in the foregoing to bring out the importance of the distributing system of a water plant, regardless of size or character. In order to properly construct and maintain this important branch of a water works it is necessary to have a headquarters. Such a headquarters is quite familiarly referred to as a Repair Shop.

THE ERIE REPAIR SHOP

The Commissioners of Water Works in the City of Erie have just completed such a unit under my direction, and I trust the description of it which follows may be of interest.

The city covers 18.5 square miles, and has a population of 115,000. An additional 6,000 persons living in Lawrence Park, Wesleyville and West Mill Creek Township are served by the local water department, making the total population served 121,000 through 25,900 services.

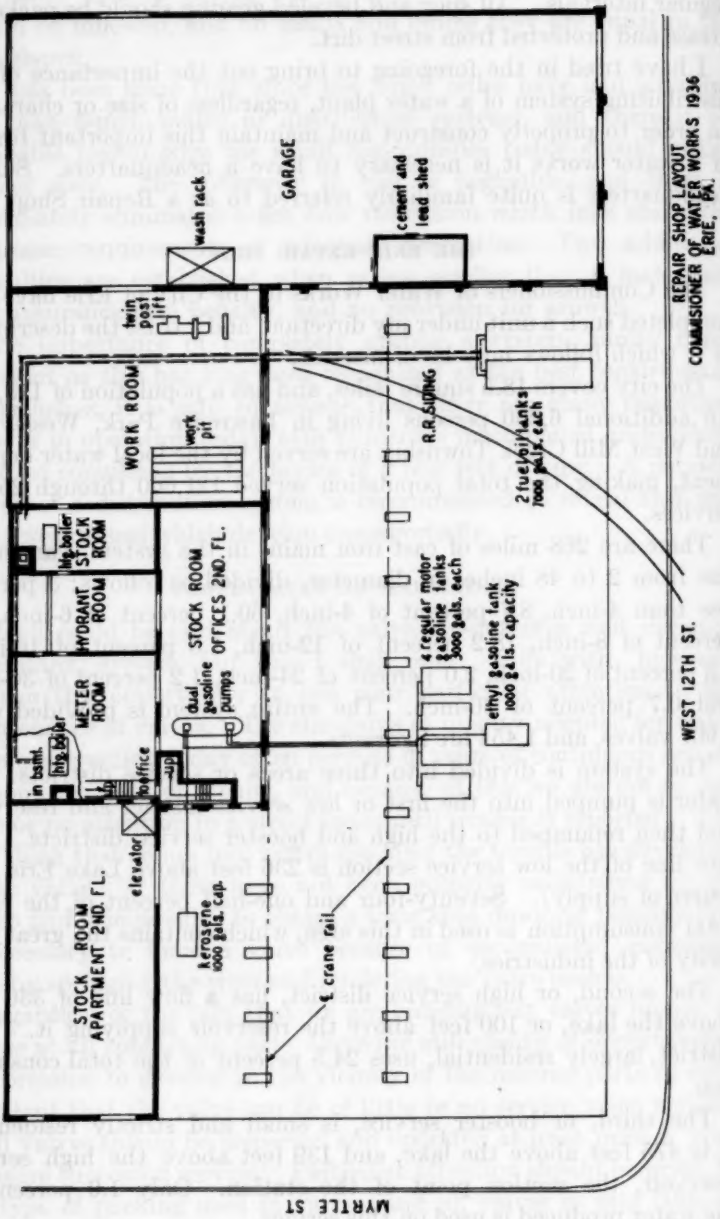
There are 268 miles of cast iron mains in the system, varying in size from 2 to 48 inches in diameter, divided as follows: 3 percent less than 4-inch, 8.7 percent of 4-inch, 60.1 percent of 6-inch, 0.3 percent of 8-inch, 18.2 percent of 12-inch, 1.5 percent of 16-inch, 4.3 percent of 20-inch, 2.0 percent of 24-inch, 1.2 percent of 30-inch and 0.7 percent of 36-inch. The entire system is provided with 3,907 valves, and 1,454 fire hydrants.

The system is divided into three areas or service districts. All water is pumped into the first or low service district and reservoir, and then repumped to the high and booster service districts. The flow line of the low service section is 236 feet above Lake Erie (the source of supply). Seventy-four and one-half percent of the city's total consumption is used in this area, which contains the great majority of the industries.

The second, or high service district, has a flow line of 336 feet above the lake, or 100 feet above the reservoir supplying it. This district, largely residential, uses 24.5 percent of the total consumption.

The third, or booster service, is small and strictly residential. It is 475 feet above the lake, and 139 feet above the high service reservoir, the suction point of the station. Only 1.0 percent of the water produced is used on this service.

The repair shop, recently completed, is located close to the vital


REPAIR SHOP LAYOUT
COMMISSIONER OF WATER WORKS 1936
ERIE, PA.
GARAGE
wash rack
cement and lead shed
twin post lift
WORK ROOM
work pit
R.R. SIDING
2 fuel oil tanks 1000 gals. each
Htg. boiler
STOCK ROOM
HYDRANT ROOM
STOCK ROOM OFFICES 2ND. FL.
4 regular motor gasoline tanks 3000 gals. each
ethyl gasoline tank 1000 gals. capacity
15 FOOT ALLEY
in bath.
htg. boiler
METER ROOM
dual gasoline pumps
office
elevator
STOCK ROOM APARTMENT 2ND. FL.
kerosene 1000 gals. cap.
5 ton crane rail
WEST 12TH ST.
MYRTLE ST

parts of the system. It borders the industrial district, is only three blocks from the center of the commercial district, and is not over a mile from the principal pumping station or largest reservoir.

The plot of ground contains 1.035 acres, with about 50 percent of this area being occupied by buildings. The balance of the yard is used for the storage of fittings, etc. Pipe storage is provided at another location.

This has been the site of the repair shop since 1912. The buildings recently completed makes the second major addition, the first being completed in 1925.

TYPE OF CONSTRUCTION

The original building and the addition of 1925 are of solid brick wall construction on concrete foundations, with a flat built-up roof laid on a wood deck. All ground floors are concrete, while the floors of the second story are of wood on wood joist. Steel supporting columns were used throughout. Wood casings with wood window sash and wood doors were installed. The area of this part of the completed unit as it exists today is 26 percent of the total.

The addition just completed matches the old building as far as possible, with the exception of the complete elimination of wood from all structures. Steel frame construction was used with concrete block walls brick faced on the outside. The roofs are the flat built-up type, and are laid on a Naylegrip deck. Steel window casings and steel doors have been installed throughout. The second story wood floors are laid on a poured Naylegrip deck supported by steel joists.

It is important to bear in mind that all work on the distribution system and its connecting reservoirs, whether it be construction or maintenance, is handled out of this shop. All emergency calls, night or day, terminate at the shop. A six room apartment is provided for the housing of a foreman and his family, so that there is always an employee of the department available to receive an emergency call outside of regular working hours.

The garage, or general storage room for all equipment, is a room 155 feet long by 72 feet wide by 16 feet high, containing 11,136 square feet of floor space. This room was designed and built with no supporting columns on the floor. With this free floor space it is possible to arrange for the housing of 28 pieces of large equipment in such a way that any one piece can be moved to an exit without disturbing any other stored unit. It is possible, through a dead

storage arrangement, to house 50 pieces of equipment at one time and not have to shift more than one vehicle to move any other unit to an exit.

One end of ths room is equipped with three double lift pier type steel doors, which permit of the movement of equipment across the entire width of the building, either incoming or outgoing. Two other outside exists are provided on the two opposite sides of this room. They are provided with the Byrne type canopy steel doors. One additional opening leads from the garage into a work room used exclusively for the maintenance and repair of motor equipment. All door openings are 14 feet by 15 feet.

Sufficient floor space is set aside, with a properly arranged drain, for use as a wash rack. Provision has also been made in this garage for the storage of a car load of cement, and a like quantity of jointing compound, by constructing a separate room 11 feet by 22 feet of concrete blocks supported by steel columns.

There are very few things more destructive to motor equipment than to permit its exposure to weather when not in use. By this addition to the plant at Erie we have provided for the complete housing of all equipment in a central location where it can be easily supervised by the superintendent of distribution.

MOTOR REPAIR ROOM

The maintenance and repair of motor equipment becomes important with the growth of a water works. It would not be wise to provide for the complete repair of equipment where there is a fleet of less than a dozen units. With larger fleets there is real economy in providing for such maintenance, under the direction of competent motor mechanics and machinists.

To handle this important service a work room has been installed in the recently completed addition at Erie which, we believe, provides for all the needs of expert motor vehicle maintenance. The total floor space is 3659 square feet. In addition to the doorway leading from the storage room, two canopy type steel doors provide for the admission of equipment from the outside. Everything pertaining to the successful handling of equipment repairs has been, or soon will be, installed in this work shop. A complete machine shop, blacksmith's forge, hydraulic lift, full sized repair pit, and floor cranes are some of the major items which have been provided. Five pieces of equipment can readily be handled at one time.

Considerable attention was paid to the provision of ample daylight at this particular section of the new addition. Light is admitted from two sides and the roof through 1160 square feet of glass, arranged in a way that produces an even distribution to all parts of the room. The success of our efforts along this line can best be appreciated by direct observation. A bright airy room has been established in which mechanics can work, under normal outside light conditions, without the need of artificial illumination.

The third item in our Repair Shop equipment is probably the most vital to successful and economical operation of a water distribution system. I refer to the stock room and its maintenance.

STOCK ROOM

To have a well balanced stock and see that it is properly distributed is one of the important functions directed by a water works superintendent. In Erie we have had in operation for several years a stock record system and check. There has been just one fault with the operation of our stock handling scheme, and that was the lack of sufficient space for systematic placing and handling. By the addition just completed we have added to this kind of space, so that today we have 10,450 square feet for inside stock storage. It is now sufficient to permit of the storage under roof of the complete stock of valves and hydrants.

The arrangement of the stock room is such that it is accessible to to no one but the stock clerk, and by him only through the distribution superintendent's office where his desk is located. Distribution doors are available at three widely separated points for the convenience of foremen or others having need of stocked materials or equipment.

The meter repair room, 1330 square feet in area, is unchanged as to size and location within the building, but the equipment has been completely rearranged to conform with the new layout. A large space for meter repair and testing is not required in Erie as these are less than 1200 in use. Only the industrial, commercial and large apartment house users are supplied by meter measurement.

RECORD SECTION

1640 square feet of office floor space have been provided on the second floor, and divided into three units. The Superintendent of Distribution occupies the principal office. This room is sufficiently

large, 23 feet by 37 feet, to give desk space to the superintendent's clerk and the stock clerk. Arrangement for record files, wall maps, and other incidentals pertaining to the proper operation of a distribution system have been given consideration in the layout of this room.

The more exacting a department is regarding its records of costs, the more important it is that each foreman responsible for carrying out construction and maintenance orders be given desk space to keep his records properly. The second office, 19 feet by 33 feet, which is directly connected with that of the superintendent, is used exclusively by the men in charge of unit operations. Individual desks are provided, and it is here that the detailed records are prepared for the accounting department.

The third unit is the engineers office, 18 feet by 20 feet, equipped with a drafting table, print filing cabinets, and the other necessary adjuncts of a civil engineer's office.

CAR LOAD SHIPMENTS

A railroad siding is provided into the shop grounds. This permits quick and inexpensive handling of material which can be purchased to advantage in car load lots. A traveling crane runs the entire length of the open yard so that heavy supplies received by car for outside storage can be quickly transferred to their proper location.

The convenience of being able to handle car load shipments has encouraged the installation of two 7,000 gallon steel tanks for the storage of fuel oil used in heating, and four 3,000 gallon steel tanks for the storage of gasoline. By purchasing in this manner we are able to make substantial savings on both of these commodities. Large storage makes it possible to take advantage of low markets. It also avoids the inconvenience of numerous tank wagon quantity orders and deliveries. Our requirements are approximately 20,000 gallon of fuel oil and 35,000 gallon of gasoline a year.

The servicing of all motor equipment with gas and oil is done by the stock clerk in a room arranged for this one purpose. A car lane is provided on both sides of a filling platform. On each end of this platform is installed a twin filling pump. Motor gasoline can be drawn from either end. This facilitates the loading of a car or truck regardless of the location of its fuel tank. Untreated gasoline and kerosene are supplied through the other two pumps. Motor oil, air and water are also supplied from the filling platform.

The plant is heated by two steam boilers. A vapor system for the old part of the building, and low pressure steam for the new. Oil is used for fuel. The burners on each boiler are the same, and are built to handle oil of 14 Baume gravity. This grade of oil is readily obtained in car load quantities and has a very high B. T. U. content.

Thermatostatically controlled unit heaters are used on the new system in the large exposed rooms, while radiators with electrically controlled valves regulated by room thermostats are installed in the offices.

Many special features have been installed to provide convenience of operation at this repair shop. One is typical. The principal doors leading into the building are electrically operated by remote control. At the desk of the clerk in the superintendent's office is installed the control box which permits him to open or close the doors most used in the general work of the Shop. As no provision has been made for door operation from the outside, this arrangement permits a truck driver, by signal, to have a door opened without him leaving his truck.

VALUE OF SHOP AND YARD

The book value of the land occupied by the shop and yard is $60,800.00. The replacement value of the completed building is $145,500.00. This makes a total investment, exclusive of fixtures, stock and equipment, of $206,300.00.

Your first thought may be that this is a large sum of money to have invested in a repair shop, but when you consider that this investment is for the proper maintenance of a distribution system valued at $5,900,000.00, that 121,000 persons are dependent upon the continuous operation of this system for one of the greatest necessities of life, and that fire protection is assured to Erie only through the reliability of its water distribution system, then the sum of $200,000.00 can easily be considered a wise and thoughtful expenditure to guarantee uninterrupted service.

(*Presented before the Central States Section, August 20, 1936.*)

HYDRANTS AND GATE VALVES

By C. S. Gruetzmacher

(*Engineer of Distribution, Milwaukee Water Works, Milwaukee, Wis.*)

Professor Daniel Meade of the University of Wisconsin Engineering School has told us that "swamps are the visible evidence of the presence of ground water." In like manner, we may say that the hydrants and the valve boxes in the city streets are also visible evidences of the presence of a buried water distribution system. The hydrants and valves are important adjuncts thereto and their number roughly indicates the strength of the underground system.

HYDRANTS

Hydrants are usually made of cast iron with bronze mountings for the wearing surfaces and are hand operated by means of an easily transported wrench. This ease of operation is too often a cause for their misuse by irresponsible parties. Hydrants are designated by the length of barrel necessary to provide the proper bury above the water main, and their size by the diameter of the main valve opening.

Modern trends in hydrants design have sought to beautify them through the use of the octagonal shape, to save on damageable parts through the use of special breakdown sections and to improve upon the various features of its construction. The use of removable flanged sections and removable main valves assemblies have facilitated easy and economical repairs. Some hydrants have been made strong enough to resist the shock of collisions in modern auto traffic, others have been weakened in a set place in order to lessen consequent damage. The hydrant has certainly received attention of late!

Hydrants are known as compression or non-compression types, dependent upon their main valve closing either with the water pressure or against it. They are equipped with either a single or a double combined hose and ste mer nozzle or with two side hose nozzles and one main steamer connection. The City of Milwaukee

has adopted the single combined hose and steamer nozzle, because the double outlet is a nuisance for steamer connections.

In residential districts, where blocks are 600 feet in length, one hydrant is placed midway between side streets, and one at each street intersection, where it is placed upon the cross main of the gridiron system. In commercial districts, two hydrants are placed diagonally across from each other at street intersections, while in congested value districts, as many as four hydrants may be located at one street intersection. Local requirements govern their installation. Additional hydrants are placed elsewhere and are used mainly as air and water blow-offs in operating practice.

Hydrants have been painted many colors, not only that they may harmonize with their surroundings in some cases, but that they may actually stand out in contrast thereby, dependent upon the local dominant viewpoint. In the City of Milwaukee, regularly set hydrants are painted red, with a yellow top in order that they may be easily identified by day or by night. But in the cases of hydrants which are branched off of, let us say, north and south mains and are located upon interesecting east and west side streets, they are painted a solid yellow color. This yellow color informs the valve operator that such hydrant's shut-off valve is located in the north and south street and not in the east and west street toward which its nozzle points.

Most hydrants should be equipped with valves in their branches to facilitate quick shutoffs in case of accidents and to allow repairs to be made without shutting off the water supply to consumers. In some instances, it is better where the supply main is of 6- or 8-inch diameter, and sometimes even of 12- and 16-inch diameters, to set two main valves, one on each side of the hydrant, and immediately adjacent thereto. This is done in order that more than a single section of main may be serviced by the one hydrant.

During construction operations, a hydrant is useful in determining whether a section of water main is valved off tightly before it is cut through for proposed connections. A hydrant in the given section is then opened and a leaking valve is disclosed by water being discharged from the open hydrant. Hydrants also act as air vents when refilling mains. It is our endeavor to locate one such hydrant within each main shutoff.

The excavation for setting a hydrant under normal conditions, consists of a trench at least two feet in width with the hydrant end

of the trench cut vertically, where possible, and within 12 inches of the hydrant. It is preferable to dig hydrant excavations by hand or with an excavating machine whose cutting buckets run vertically. The type whose boom is inclined to the vertical should not be used. A vertically cut trench back of the hydrant provides the proper surface against which to place the wood blocking. A 2- x 12-inch piece, 12 inches long, is placed against the wall with a 6- x 6-inch horizontal piece against the hydrant. Wedges are then driven tightly between it and the hydrant to prevent future blowoffs. When loose soil conditions are encountered, the hydrants are strapped to the main with wrought iron rods.

Whenever hydrants must be set within hollow walk areas, an opening in the curb wall at least two feet square is made to allow for the entrance of the hydrant pipe and the drain tile. A suitable foundation for the hydrant is then prepared in the bottom. A brick wall, eight inches thick, is then built up around the hydrant extending to the underside of the sidewalk, with at least twelve inches clearance about the hydrant. One practice in draining hydrants, is to lay drain tile in two feet sections from one of the two waste holes of the hydrant (the other being closed with a plug) to the adjacent sewer. Should no sewer be available, sufficient drain tile is laid in the hydrant trench to and along the water main trench until a point is reached where its volume is equal to three times that of the hydrant barrel, which is to be drained. A half of a cubic yard of crushed stone is then placed around the end of the tile drain. In the future if a sewer is constructed nearby it is required that the hydrant drain tile be connected to it.

Hydrants should be set back far enough from the curb not only to prevent damage to the fenders of cars moving parallel to the curb, but also to those of cars which may turn out from the curb near the hydrant. Hydrants whose nozzles are too low, should be raised for the same reason. Our hydrants are set to a center line distance of 2 feet back of the curb and with nozzle 18 inches above the curb.

I have seen hydrants located in the gutters of streets in small towns. They certainly are easy to reach, too easy in fact, and I venture to predict that if the authorities do not relocate them where they belong, our traffic will cause it to be done. Hydrants should be located in safe places and as close to traffic lanes as permissible in order that a maximum use can be made of them at all times. Misuse of hydrants by contractors, etc., should be prevented whenever

possible. The frequent opening and closing of the main valve in order to obtain a bucket of water, a drink, or to wash one's hands and other similar uses is provocative of damage due to excessive wear to the valve, and thus preventing its tight closing. Quick closing of the valve is also the cause of water hammer in the plumbing of neighboring homes with accompanying noise and loosening of plaster from walls.

GATE VALVES

Gate valves used in a water distribution system are usually made of cast iron, with bronze mountings. They are either of the solid wedge or double disc type. A new type of valve, not requiring a by-pass valve, is known as the revolving cone type. At present the latter is too expensive to consider in the smaller sizes, but has its advantages when quick operation against high pressure is required.

Such valves are operated by hand or machine driven apparatus turning the operating nut either directly or through bevel gears. The use of a machine, either electrically or motor driven, saves considerable time and much labor on large valve operation.

The City of Milwaukee uses the solid wedge type of valve for sizes up to 16-inch diameter, the larger sizes being of the double disc type. Gate valves should be tested for leakage at the maximum working pressure and again at the lowest working pressure in order that any springing of the seats due to the former will show up in the latter test. The use of feet cast on the body bottoms will allow ease in the storage of the gate valves, and their setting in water main construction.

The use of by-passes on the larger valves is almost a necessity, but upon the smaller valves and where pressures are low, none are needed. We have found in our practice, that at a pressure of 100 pounds, it is difficult to operate a 16-inch gate valve, without a by-pass.

Gate valves of the smaller type are directly operated vertically through a stop box placed in the ground above the valve. Larger gate valves are bevel-geared and are set in manholes in order that easy access can be had to the gears for cleaning and lubricating.

Wherever the water main does not have sufficient cover, the valve is enclosed in a manhole, because no box is short enough to be used. All manhole covers for water service have the word "Water" cast upon them. This prevents confusion when a number of other utility manholes happen to be located in the same vicinity.

Gate valves should be located in the water main upon street lines as precisely as possible to facilitate later finding them when covered by debris or snow and ice. They should be placed in the water main so that not more than two blocks are without water in case of a shutoff. Small mains should be valved off from the 12-inch and larger sized water mains. Larger mains are valved off as operation shall require.

In constructing a water main, for those valves not set in manholes, our practice is to set them upon hard wood blocking of proper size to prevent settlement. Sufficient clay is placed and packed around the valve so that only the bonnet protrudes above. Then a 2- by 4-inch hard wood block is laid along each side of the bonnet, parallel with the water main. The valve box is then set vertically upon this blocking and clay packed around its base to a height of 6 inches. The box is braced in a vertical position and sandy gravel or earth can now be backfilled around the valve box without danger of any of it entering the box and covering up the operating nut of the valve or clogging the valve box. The cover of the valve box should have a long shaft in order to prevent its being pulled out of the box by passing traffic. Boxes should be set truly vertical and be centrally located over the valve nut in order that the operating wrench can be easily centered upon it when required.

The efficiency of gate valves is impaired by the presence of foreign materials lodging in the valve bottom. Pieces of wood, clothing, dinner pails, hemp and lost lead from adjacent improperly poured joints have been found during our repair operations. The operation of all gate valves in the Milwaukee Water Works is restricted to employees of the department.

It should be the constant care on all construction operations to see that all pipe is cleaned before being put into the main and kept so until the line is completed, as only by so doing will the gate valves and hydrants function as they should.

(*Presented before the Wisconsin Section, October 6, 1936.*)

DISTRIBUTION SYSTEM LOCATION RECORDS

By P. C. Gale

(Superintendent, Water Department, Michigan City, Indiana)

Prior to 1931, the water works in Michigan City was operated, as is the case in many municipally owned water works, by the Board of Works, the Mayor and the Council. In July, 1931, our organization in this respect was changed by creating a Water City under Chapter 236, Acts of the General Assembly of 1931, by which Acts the Water Department was divorced from the Civil City and established as a separate and distinct unit under a Board of five Trustees, very similar to a School City. Under this setup we are, of course, municipally owned, but we operate as an absolutely separate and distinct Department, even to the extent of having an office outside of the City Hall, and we handle all of our own business, including collections, purchases and payment of bills. One of the best features of this plan, I believe, is the fact that the term of employment of various employees of the Department is not subject to political affiliations, but rather to whether or not they can produce. Political turn-overs among employees of Water Departments; especially in these days of severely polluted sources of supply; the more or less complicated equipment; and the fact that the health of whole communities depends upon the efficient and intelligent operation of the water works; makes a serious situation, and one which I believe is going to have to be universally faced and corrected in the not far distant future. Where such turn-overs in employees are possible and inevitable under political setups, it only follows that insufficient and inadequate records are certain to exist.

I recall very distinctly the first day I came on the job in 1931. The foreman of the construction and maintenance department made it a point to interview me early, and during this interview he handed me several old and battered notebooks, similar to a field notebook used by engineers.

I hadn't the slightest idea what these books were for, but upon

questioning him, was informed that they were the sole and only records of the entire distribution system. A rapid survey of these books showed that they contained sketches, by various individuals, mostly in pencil, undated, and in many cases not dimensioned, and where they were dimensioned, these were often oriented to trees, hitching posts, and various other movable monuments.

If the foregoing was a sample of the distribution records, I began to wonder what the office records were like, and suffice it to say they were equally as poor, if not worse, but that is not a part of this paper.

Since, primarily, the purpose of records is to have available for immediate reference, accurate and complete information, it follows that, fundamentally, the systems used in making up and keeping location records for mains and services are the same, but they dŏ vary in different details as influenced by the local conditions.

At Michigan City we first started by endeavoring to locate and plot mains, valves and hydrants. In doing this, we used what available information was at hand, and supplemented it with personal investigation, even to the extent of making excavations. Over two years was consumed in completing this work, and we do not maintain that it is absolutely perfect. In fact we know that it is not, because in our usual run of work we occasionally find something on which we have no information. We do believe that we have a reasonably correct and workable system, and we are constantly adding to and improving it.

There was found in the possession of one of the local banks, an atlas of the City, the setup of which would apparently answer our purposes very nicely, since it was laid out in divisions and subdivisions. Using this atlas as a guide for making our own atlas, tracings approximately 20 x 24 inches were made of each page, and on these tracings the mains were plotted, showing sizes and dimensions from property lines. Also, the locations of the line valves were plotted and numbers were assigned to both the line valves and to the street intersections.

For the first page of the atlas, a small scale map of the City was drawn, and this map was divided into sections, each section being numbered to correspond to the page number of that particular section in the atlas, thereby making it possible to readily locate the desired information in any part of the City. This completed, linen prints were made and bound into an appropriate cover.

Supplementing this information, two large wall maps of the City were made, one for the office and one for the construction and maintenance department. These wall maps contained all the information shown in the atlas. Hydrant locations, however, were not shown on these maps, but instead were plotted on a separate wall map, but with no mains or line valves shown, in order to avoid possible confusion between hydrant and line valve locations.

That portion of the information contained in the atlas referring to street intersections, showing locations and sizes of mains, locations and numbers of valves and numbers of street intersections, was then transferred to a good grade engineer's field book, and these books are carried on the service truck for quick and ready reference in case of emergency shut-offs.

For the purpose of permanent office records in recording distribution mains, a 5- x 8-inch card is used, one card for each size of main, and on this card is shown the street location, between which streets the main runs, the kind of pipe, date installed, and length. As for instance, the card for 4-inch mains may show a section located on Cloud Street from Barker Avenue to Francis Street, kind of pipe, 150# DeLavaud, installed in 1935, length, 850 feet. Likewise, any other 4-inch pipe in the distribution system would also be recorded on this same card or cards. This as can be readily seen maintains a perpetual inventory of the locations and total quantities of all mains, and it has proven of great assistance, not only in making up the yearly report to the Public Service Commission, but also in regards to questions raised by insurance and sprinkler companies.

Although hydrants are not in the category of mains, they are very closely inter-related, and therefore, should be included in this discussion. As previously stated, the locations of hydrants are plotted and numbered on a wall map, and these numbers are also stencilled on the hydrant itself. In addition, an individual 5- x 8-inch card record is carried for each hydrant, giving the hydrant number, make, location, size, number and size of hose connections, number and size of steamer connections, and the location of the auxiliary valve to same. On this card is also recorded the date, the work order number, and description and cost of all repairs to the hydrant.

Another item in connection with hydrants, which has proven effective, is the notification to the Fire Department of any hydrant

out of order, by reason of repairs to the hydrant or distribution system. This is done by means of a regular form when a fire hydrant is out of order or being worked upon, this form is made up and the original given to the Fire Department, showing the hydrant number and its location. The Central Station of the Fire Department has a hydrant wall map, identical to ours, and when these notices are received, they post the hydrant out of commission, and then notify the other stations. When the hydrant is again ready for use, a similar form is issued, advising that the hydrant is returned to service.

Main line valve records are kept on 3- x 5-inch cards, using one card for each valve in the distribution system. The front side of this card shows the valve number, the size of the valve, closing direction, type of valve, inspection date, work order number, cost of repairs, if any, and remarks. A sketch on the back side of the card shows the valve location, the size and location of the main in which it is installed, and the size and location of any immediate connecting mains.

One of the most important, and yet one of the most neglected of location records, are those records pertaining to service lines.

To a large extent this can probably be attributed to the fact that some water utilities do not have jurisdiction over service lines, and that where they do, as is the case in Michigan City, they have only been taken over in recent years, and the records, if any, are incomplete. Where the water utility controls the service line, any leak appearing in the street is its responsibility; services can be repaired, replaced or cut over, as deemed best; type of pipe, fittings and depth of line can be controlled; the abandonment and cutting off of a service line without killing it at the main would be eliminated, as would also controversy and responsibility for street repairs, where pavements are cut; and, last but not least, on any new lines installed, or old lines replaced, repaired or cut over, complete and accurate records can be obtained.

A great many of us could have saved much in time, expense and patience during the past three months, when so much trouble developed with frozen and bursted service lines, if we could have definitely known where to excavate in order to gain access to a corporation cock.

Under the Government's first relief program, namely the C.W.A., we were asked to furnish a project. Although this was in the early

part of December of 1933, and the weather was not all that could be wished for, it was decided that the best possible and most useful project we could suggest would be the securing of information for location records of curb boxes, including repairs and replacements to same where necessary. Consequently, five two-men crews were organized and sent out. A foreman of our own selection, a young civil engineer, who understood and appreciated the value of accurate records, was placed in charge of these crews. The work was done in an orderly manner, each day's program being definitely laid out, the men instructed exactly what information to obtain, and the day's results turned in each evening.

Under the same project, two draftsmen were detailed to record the data turned in by the outside crews. For this purpose a 5- x 8-inch card was used, the front of the card giving the name of the property owner, address, account number, size of meter, and date service line was installed. Also on the front was provided a space for showing the work order number, date, material and labor costs and description of any work done on the service line. On the reverse of the card was sketched the outline of the building served and the location of the curb box, properly dimensioned, so that it could be easily located.

It was really surprising the amount of data that was obtained by these crews, and about 90 percent of our present information was secured through this source. These investigations also brought to light many discrepancies, which it was possible to later eliminate, and of course, the records are constantly being added to, changed or corrected as data becomes available. The location of corporation stops is not contained in these records, except where new services have been installed or old services repaired or relocated, whereby the information could be secured. It would be impossible, or rather impractical, from both the standpoint of time and expense, to attempt to obtain at once the location of all unrecorded corporation stops, and although it is anticipated that this information will eventually be obtained, it will take a long time to do so.

Any Water Department which now controls or ever contemplates controlling its service lines, should begin at once to keep location records on curb boxes and corporation stops, on each and every job with which they have anything to do. I can assure you that what little extra time and labor is involved in doing this will more than repay itself at a later date.

The foregoing covers as briefly as possible, a system of records which can be installed in any Water Department, and which if given conscientious effort, not only at the start but in maintaining them, will pay ample dividends. It is appreciated that no two persons will react exactly the same if given the same problem, but other things being equal, they will, although perhaps by devious routes, arrive at the same end, and after all, it is the ultimate results that are desired.

(*Presented before the Indiana Section meeting, April 9, 1936.*)

METHODS FOR HANDLING EMERGENCY MAIN REPAIRS

By Henry E. Nunn

(Superintendent of Water Works, Van Buren, Arkansas)

Methods for handling emergency repairs may vary greatly according to local conditions and will depend on good judgment of the man in charge, so that it would be presumption for me to attempt to outline any set rules for guidance. Rather, it seems more to the point to discuss: preparations, crew organization, adequacy and care of equipment, and maintenance. These things have a very vital bearing on "Methods for Handling Emergency Main Repairs," whatever those methods may be.

A famous general once said, "The best way to win a battle is to get there firstest with the mostest men." A good way to attack an emergency repair is to get there promptly with plenty of men. Incidentally, the men must know what to do and have equipment with which to do it. Three things are very helpful in emergency work; getting on the job promptly, competent men, and equipment in good condition.

Getting on the job promptly depends on crew organization. This is not a difficult matter during regular hours, nor is it difficult for larger plants that may have an adequate night crew. But for smaller plants it is important to have, at least a skeleton crew where it may be reached quickly at any time after regular hours. A foreman should always be within telephone call and he should know where to locate members of his regular crew.

Efficiency will depend in a large measure on accurate and dependable records. Mains, valves, and hydrants should be mapped accurately and the foreman should be able to read the map and should become familiar with the system, so that in case of trouble he will know where to go, which valves to cut off, and what section of the system will be affected by the break. This is of importance to the fire department and to interested consumers.

Men should have the tools they need. It is poor economy to pay two men to use the same tool when each might have one for what is

saved in a few hours work. Even though the supply may be limited, equipment can be kept in condition and where it may be found. The emergency crew should have a place for tools where they may be found and it should be responsible for their condition. It is embarrassing as well as costly to have a break and find; your picks and drills dull, your hoist at the plant, the ditch pump in some councilman's cellar, with other tools scattered here and there. After each job, time is saved by looking over all equipment used and seeing that it is in condition to go on the next job.

A job should be completed in a thorough manner. Throwing something together in a slipshod way may cause more grief on the second trip than was found on the first.

Upon arriving at a break, the work usually depends on local conditions and good judgment. However, it is always well to have room in which to work. Besides having good tools, room is needed to use them. It is wise to dig a trench big enough in the beginning; so that it will not be necessary to dig it out again when the job is almost finished, after much time has been wasted working in cramped quarters. Ample provision should be made to take care of leakage and seepage. A crew cannot make much headway with water all over the pipe. It will probably have to be bailed or pumped out any way so time wil be saved in digging a sump and being prepared to handle it from the beginning. A little digging may let this drainage into a storm sewer, provided the foreman is familiar with the storm sewer system.

The same necessity is present for care and good workmanship as was present when the pipe was laid originally. There is just less time in which to do the work. Sometimes an investigation will uncover the cause of the trouble, giving one a chance to correct it and avoid the same trouble in the future. For instance, if there is a high rock in the trench near the break, it should be removed—solid rock should be excavated well below the grade line—and the trench brought up to grade with well packed earth, to avoid settlement.

In working with broken pipe where there is no bead, it is possible to loosen the broken pieces and pull them out. Then, by working a joint or two loose in each direction, a full joint of pipe may be buckled into place to replace the two pieces. In some cases this may be more practical than using a sleeve. The labor will be increased but the cost of a sleeve and a joint is saved. A little more excavation and a little more caulking will be required.

Another item of importance, sometimes neglected, is proper consideration of the consumers when it is necessary to shut off a line for repairs. They should be notified as soon as possible and given some idea of the period of time they will be out of water. Immediately on arriving at a break, it is worth while to send a man to notify all who are affected, that they may prepare themselves, by drawing water, cutting off boilers and heaters, and taking any other precautions they may desire against their inconvenience. This pays dividends in good will and encourages citizens to remember the department when they see any trouble and to report it. Parkways and driveways should be littered up as little as possible and entirely cleaned up after the work is finished. In replacing pavement quick setting cement is worth the added expense.

Work should be well protected by barricades and lights. Aside from the question of liability for accidents, more efficient work is done if the workmen do not have to worry about passing traffic getting too near.

The Fire Department should be notified which mains and hydrants are out of service and which streets are blocked. The Fire Chief will appreciate being notified when the repair is finished. A check up should be made to be sure that all valves have been opened after the line is back in service. Good judgment should be used in turning the water back into the line.

A mighty good way to simplify the problem of emergency repairs is through maintenance. Sound maintenance will lessen the number of emergency calls. If a leak is fixed in time, it not only saves water but may save a call in unpleasant weather at an inconvenient time. It is well to inspect dirt streets in late summer or early fall and to find out how much pipe the street crews have left uncovered so as to get it lowered before freezing weather. Although the pipe was laid deep originally, grading and erosion may have left it too near the street surface. Valves should be kept in condition. It is good practice to inspect all valves each year and have a man close and open each valve in the system.

In summarizing, important items in meeting emergency repairs are: have an organization that is able to function promptly and efficiently at all times; have up to date and accurate records of the system; know the system and keep workmen who do; and keep up maintenance.

(*Presented before the Southwest Section Meeting, October 16, 1935.*)

THE SUCCESSFUL CAMPAIGN IN NEENAH FOR WATER PROGRAM APPROVAL

By Mr. S. F. Shattuck

(Vice-President Kimberly-Clark Corporation, Neenah)

THE PROBLEM

1. A Citizens' Committee, working on unemployment and new industry for the Community, found themselves blocked by the nature of the city water supply.
2. City water with hardness of 70 grains per gallon from wells. Unusable for most industrial or domestic purposes.
3. In spite of the hardness there existed a deep popular prejudice against a treated surface water and in favor of well water.
4. Vote on the question in Spring of 1932 was 2 to 1 against a proposed change to treated lake water.
5. Popular suspicion was that the three larger industries wanted the change for industrial purposes.
6. Alternatives: Another well system using veins of 20 grains hardness with sulphates and iron to contend with or resort to Lake Winnebago, 10 grains hardness.
7. Obviously, solution of the problem lay largely in the field of sentiments, beliefs and habit life, of the majority.

Problem demanded intensive study of the physical aspects on part of Citizens' Committee but method of solution must be psychological rather than physical.

An extended time element necessary for campaign (Sept. 1, 1935, to April 1, 1936) Prejudiced minds can't be rushed.

MAIN FEATURES OF THE ATTACK

1. Purchased an experimental water plant for treatment of lake water—located on main travelled street (240 gallons per hour).
2. Secured an operator who possessed salesmanship qualities.
3. Established relations with State Board of Health.
4. Assured coöperative attitude of press.

5. A public plea for open minds made by the Editor of the daily paper.
6. Established confidential relations with Water Commission.
7. Took public into confidence with a primer-like description of "What happens to lake water in the experimental plant,"—step by step,—coagulation, chlorination, lime softening, filtration, activated carbon, etc.
8. Campaign was privately financed.

WHAT WE DID

1. Talks made over the 8 months' period before groups and organizations—civic, school, church, social. Exhibiting samples of water from other cities, clogged pipes from local city water, soap demonstrations, etc., etc.
2. Store window displays made.
3. Amateur cartoons exhibited.
4. Washing machine demonstrations made using water from experimental plant.
5. Served water from experimental plant at dinners of luncheon clubs, churches, lodges.
6. Booth used at home show.
7. Weekly newspaper releases made,—open forum articles most effective.
8. Obtained and released news stories of water experience of other cities.
9. Published research report of coffee concern after laboratory experiments on water from experimental plant.
10. Specific news released in story form on topics such as:

A. How we get our well water.
   Where it comes from?
   How does nature filter and purify it?
   Some of the hazards of nature's method.
   How man-made processes improve on nature's method.
B. What waters can be softened by the lime process and why?
C. What is hardness?
   How is it measured?
   What are the different kinds of hardness?
D. What is activated carbon?
   What does it do to tastes and odors and how?

11. Articles written for open forum column by young men voicing what a soft all purpose water would mean to them.
12. Comparison made of recent building statistics of Neenah with statistics from neighboring cities which have an all purpose water.
13. The cost and nuisance of cisterns, double systems of plumbing demonstrated, etc.
14. Experience and impressions of citizens who have lived elsewhere recorded.
15. Research into and compilation made of water business which is now lost to our Water Commission.
16. Published letters from business such as laundry, engraving company, building supply men, stating the annual penalty of doing business in Neenah.
17. Testimony of those who had passed Neenah up when making decision on where to build a home.
18. Delivery service of 3 gallon bottles from experimental plant to prejudiced neighborhoods established.
19. Signed endorsement of physicians of city in favor of surface supply, as demonstrated by experimental plant.

HOW CAMPAIGN WAS EMOTIONALIZED

After six months of the program outlined above we realized that, whereas it was truthful, factual and logical, something more was needed. The seed had been planted, but it needed warmth and fertilizer.

The situation called for an emotional charge. This was achieved by assembling all vital information in a pocket sized booklet, and recruiting a district committee of 72 men and women personally to place a copy in the hands of every family. At the same time opportunity was given every resident to register his or her name on a petition in favor of the proposed change. This house to house campaign proved to be the needed spark plug.

FINALLY

One of the Citizens' Committee proposed that we thank the Community for their open minded, receptive attitude and do it before rather than after election. This was done on the eve of election.

NET RESULT

A 4 to 1 favorable vote.

(*Presented before the Wisconsin Section Meeting, October 7, 1936.*)

THE PROGRESS OF LICENSE LEGISLATION IN NEW JERSEY

By Charles H. Capen, Jr.

(*Engineer, North Jersey District Water Supply Commission, Newark, N. J.*)

Twenty-one years ago, a number of men whose names have since become prominent in their chosen field, banded together and formed the New Jersey Sewage Works Association. Some of the motivating forces were the desires for mutual cooperation, dissemination of experiences and knowledge and the desire to obtain protection of men engaged in that line of work from the ravages of the patronage system. The first two aims were accomplished by meetings. The third was aided by means of the passage of Chapter 23 of the Laws of 1918 whereby water and sewage treatment plant men were licensed.

Without question the license law has been of material benefit to many men. In the early years of its existence, during which time the writer had an opportunity to aid in its administration, it was heralded as an outstanding achievement. The qualifications of men affected have been raised to a far higher level than formerly, but eventually it was found that the law lacked "teeth." For instance, there was no method of preventing the removal of a licensee and replacing him with another licensee. There was no way of withdrawing a license, once it had been issued, except upon dereliction of duty. Thus a man could obtain a license, later resign from his position and finally be reappointed to fill the place of his successor or any other licensed man of a similar class elsewhere who might be removed from office.

The question was raised and debated in several of the meetings of the Sewage Works Association, committees were appointed, and many suggestions were made regarding legislation to remedy the situation. Meanwhile the State Department of Health revised its classifications and the examinations showed a constant upward revision in requirements.

Whereas most of the early cases of unwarranted removal from

office involved sewage treatment men, the water works men began to come in for their share of difficulties and, mainly as a direct result of this, the New Jersey Water Works Association was formed, having as its chief aim the enactment of protecting laws for those of its members holding offices subject to political upheavels. A great deal of time and effort was spent in 1931 and 1932 by representatives of the two associations in trying to pass a law to overcome the difficulties, but to no avail.

JOINT COMMITTEE FORMED

Recognizing that a still more concentrated effort would be required to obtain tangible results, a large joint committee was formed in the early part of 1935, consisting of representatives from both of the two mentioned associations and also the South Jersey Association of Water Superintendents. Later the newly formed New Jersey Section of the A. W. W. A. expressed its views in favor of such legislation and members of the Section served on the committee.

Although there was no opportunity to submit preliminary copies of proposed bills to each of the associations at regular meetings, a definite course of procedure was outlined and competent legal advice was obtained when drafting the final copies.

At this time it was learned that the original idea of securing protection for all water and sewage works men was not feasible for the reason that the Courts of the State had already held that such action virtually legislated Civil Service on the political entities employing such men and that this was not valid. It is important to note that while all State employees are under Civil Service, only those municipalities that have chosen to adopt Civil Service under an enabling act, have protected their employees to this extent. The number that have done so are relatively few.

Having decided that only one person for each system could normally come under the proposed protection, the Acts providing tenure for Health Officers and Municipal Clerks were studied and were used as a guide because they have stood the test of time. Eventually these were used as a pattern in drafting the new bills.

With the universal clamor for economy, it was evident that no new board could be set up for administering a new law and upon legal advice it was decided to draft legislation so that it would be mainly supplemental to the existing licensing law. By leaving it under the jurisdiction of the State Department of Health, the ex-

isting machinery for administration could be used without further expense. Fortunately this contingency had been to a certain degree anticipated when the committee appeared before the Board of the State Department of Health at its meeting of January 1936 and obtained its general approval of legislation of this type.

Since existing tenure acts, by force of circumstance, give protection only to the one at the head of each civil division, it was decided to pattern a bill on this premise. Experience has shown that where the head person is thus protected, the added sense of security permits him to use a broader field of powers in "going to bat" for any worthy employees who may have incurred the displeasure of elective heads of the respective departments. The practice of removing lesser employees from health and municipal clerk departments has diminished noticeably and the tenure acts affecting these departments are no doubt in a large measure responsible.

PRIMARY OBJECTIVES OF NEW BILLS

There are two primary objectives around which legislation was to be drawn; first, the inclusion, under the licensing laws, of the head person of each system or department and, second, the protection of that person's tenure of office. After some deliberation, it was decided to separate these two principles into separate bills because the first involved mainly the amending and supplementing of the original licensing act while the second was an entirely new principle. Furthermore, precedent existed in New Jersey in the case of various similar Acts relating to health officers, wherein the examination and licensing are stipulated in one act and tenure in another.

With this in mind two bills were drawn, one of these (which became Assembly 125 when introduced in the 1936 legislature, generally called the "fee" bill) arranging for the inclusion of the heads of all systems and the other (Assembly 124, generally called the "tenure" bill) providing tenure for these head men. Copies of these bills as they are at present amended for presentation to the 1937 legislature are appended to this paper.

Since it is required that each Act in its title describe its purpose and since it was noted that the title of the original Act specifically referred to treatment plants only, it therefore became necessary to provide an amendment to the title to include "*other persons* in charge of water purification or treatment plants and sewage treatment plants and *superintendents of water supply systems.*" The use of any

words alluding to sewers was deliberately omitted because it might be construed to mean storm sewer systems and no such intent was desired. Furthermore, the heads of sewage treatment plants are in most cases the ones now licensed and would automatically come under the provisions of these two bills.

SPECIAL FEATURES

Some of the paragraphs of A125 require further explanation. Paragraph 4 distinctly states that the act shall not affect "the tenure, term or status of any person requiring a license." This was drawn because in some instances heads are appointed for a given term of years and no act could be expected to be retroactive with respect to such an appointment.

The annual expiration of licenses, coupled with the fee, was proposed for the purpose of eliminating some types of unused licenses. An example has occurred where a licensed operator was removed from office with a change in the political complexion of his municipality. Another man, who had held the position at an earlier date, but had subsequently gone into other lines of endeavor, was out of work but was in favor with the new party in power and received the appointment. As a license holder, he was qualified, in a sense, but the addition of many new units at the plant had involved new methods with which he was totally unfamiliar. It is extremely unlikely that this man would have paid an annual fee for maintaining a license or that he would have spent the necessary time to qualify to operate the new units. Nevertheless, it was difficult under the existing law to prevent the change.

The size of the annual fee probably provoked more discussion than any other one clause. It was arrived at after much deliberation and the intention was that the minimum figure (three dollars) would be used, it having been previously estimated that this amount would about pay for the cost of administering the Acts.

At first no provision was made to exclude potential or existing license holders in private companies from the provisions of A125 although they were necessarily excluded in A124. The injustice of charging a fee in these cases without also offering anything in return, led to well deserved comment by the men so affected and a subsequent clause was inserted in A125 to exclude them but to leave their status exactly as under the original Act.

The all important question of relief legislation so occupied the

time of the past legislative session that many bills of non-partisan type failed to receive much consideration. These bills passed the first hurdle of being reported out of Committee but failed to be presented for second reading because of objections that developed out of a situation where a certain man, appointed for a given term, might have precipitated litigation had both been passed. It is possible that one might have been passed alone but on advice the two were held together and remained deadlocked. This stumbling block is expected to be eliminated before the next session of the Legislature and with the experience gained so far, the chances of obtaining greater consideration for the Bills seem reasonably good.

This brief history is written in the hope that it may inspire similar action elsewhere and that constructive suggestions may be obtained from those interested.

ASSEMBLY BILL NO. 124 STATE OF NEW JERSEY

AN ACT concerning persons in charge of public water systems and sewage disposal or treatment plants

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

1. No person now or hereafter licensed under the provisions of an act entitled "An act to provide for the examination and licensing of superintendents and operators in charge of water purification or treatment plants and sewage treatment plants under the direction of the Department of Health of the State of New Jersey," approved February ninth, one thousand nine hundred and eighteen, and the amendments and supplements thereto, having direct general charge of the operation and maintenance of public water systems and sewage disposal or treatment plants after five years' consecutive service in any such position shall be removed from his position except for good cause and after a public hearing. In computing such five years' service the time served before the passage of this act shall be included, as well as time served after the passage hereof. The public board, officer or commission having power of appointment of any such person or having the power to appoint a successor of any such person whom it is sought to remove, shall formulate or receive charges, in writing, against such person and shall fix a time and a place for a hearing thereon. A written copy of the charges and a written notice of the time and place of the hearing shall be served upon the person sought to be removed at least five days prior to the hearing. At the hearing the public board, officer or commission shall hear all witnesses and receive all evidence produced and if the charges are found to be true in fact and just cause be shown, the public board, officer or commission may remove the person against whom charges are made.

2. The purpose of this act is to prevent the unwarranted removal without just cause of the individual who is now or shall hereafter be directly responsible for and in direct charge of the maintenance and operation of public water systems and sewage disposal or treatment plants. This act shall not, how-

ever, affect any public officer whose term of office is now or shall hereafter be fixed by statute.

3. This act shall not apply to private corporations engaged in selling water to the public, either at wholesale or retail or to private corporations owning and operating public sewage treatment plants.

4. All acts or parts of acts inconsistent with the provisions of this act be and the same are hereby repealed and this act shall take effect immediately.

STATEMENT

The purpose of this act is to secure a measure of continuity in office and position of persons responsible for the operation of water systems and sewage disposal or treatment plants. It is essential in the preservation of public health that the operation of such plants should be in the hands of experienced operators and not in the hands of constantly changing and inexperienced personnel. This legislation has been approved by

New Jersey Water Works Association
New Jersey Sewage Works Association
New Jersey Section, American Water Works Association
South Jersey Association of Water Superintendents
Department of Health of the State of New Jersey

ASSEMBLY BILL NO. 125 STATE OF NEW JERSEY

AN ACT to amend the title of an act entitled "An act to provide for the examination and licensing of superintendents and operators in charge of water purification or treatment plants and sewage treatment plants under the direction of the Department of Health of the State of New Jersey," approved February ninth, one thousand nine hundred and eighteen, and to supplement said act by adding further sections thereto.

BE IT ENACTED by the Senate and General Assembly of the State of New Jersey:

1. The title of the act to which this act is an amendment be and the same is hereby amended to read as follows:

An act to provide for the examination and licensing of superintendents and operators *and other persons* in charge of water purification or treatment plants and sewage treatment plants *and superintendents of water supply systems* under the direction of the Department of Health of the State of New Jersey.

2. The act to which this act is a supplement be and the same is hereby supplemented by adding thereto the following sections:

1. Where the words "superintendents or operators" are used in this act, they shall be construed to include, in addition to the classifications already established by the Department of Health of the State of New Jersey, all persons under any title or designation who are now or shall hereafter be in direct general charge of water supply systems, as distinguished from subordinate persons or employees engaged in the direction or operation of such water supply systems or of water purification or treatment plants.

2. All of the provisions of sections one, two, three, four, five and six of the act to which this act is a supplement, shall apply to the additional persons

hereinbefore designated, insofar as may be, and the Department of Health of the State of New Jersey is hereby authorized to adopt such additional rules and regulations for this purpose as may be required.

3. Nothing herein contained either by reason of any defect or inconsistency in the title or sections of this act, or for any other reason, shall be held to abate or render invalid any notice or proceeding, or suit at law or in equity, which may have been served, begun or instituted by the Department of Health of the State of New Jersey, prior to the date hereof, in accordance with the powers and duties heretofore conferred upon it, but the same shall continue in full force and effect and be further advanced and prosecuted in the name of the Department of Health of the State of New Jersey.

4. Nothing in this act shall be construed to in any wise affect the tenure, term or status of any person holding a position requiring a license under the provisions of this act at the time of the passage of this act.

5. All licenses issued by the Department of Health of the State of New Jersey under this act and the act to which this is a supplement shall expire annually and may be renewed by application to and under rules and regulations to be adopted by the said department.

6. The Department of Health of the State of New Jersey shall be entitled to receive a license fee for each license originally granted, to be collected from the licensee, and shall also be entitled to an annual fee for the annual renewal of such licenses from such licensees, such fees to be not less than three dollars ($3.00) nor more than five dollars ($5.00). All such fees shall be paid over by the Department of Health of the State of New Jersey to the Treasurer of the State of New Jersey monthly.

7. This supplement shall not apply to private corporations engaged in selling water to the public, either at wholesale or retail, or to private corporations owning and operating public sewage treatment plants.

8. All acts or parts of acts inconsistent with the provisions of this act be and the same are hereby repealed and this act shall take effect immediately.

STATEMENT

This act is a public health measure in that it requires all persons directly responsible for conveying water to the public to adhere to the standards of health safeguards set up by the Department of Health of the State of New Jersey. It requires both water and sewage plant licensees to renew licenses annually and provides revenue for defraying the cost of the work. This legislation has been approved by

New Jersey Water Works Association
New Jersey Sewage Works Association
New Jersey Section, American Water Works Association
South Jersey Association of Water Superintendents
Department of Health of the State of New Jersey.

THE COMPARISON OF ODOR ELIMINATION TREATMENTS

By Oscar Gullans

(Senior Sanitary Chemist, Division of Water Purification, Department of Public Works, City of Chicago)

The treatment of surface water supplies for the elimination of tastes and odors has advanced rapidly in the past few years and there are now several methods of treatment available to the water works operator. Each of these methods has its merits in removing or preventing tastes and odors, some being more selective than others and adaptable only under certain conditions. We are confronted then with the problem of selecting the method of treatment that will be most efficient, economical, and best adapted to our needs. To assist in this decision, the method of testing the raw water described here is suggested as a means of determining rapidly and quite accurately the best treatment to use. The results of experiments using this method are also presented.

Realizing that the comparison of odor elimination treatments must depend on a sensitive odor test, considerable attention was given during the past year to improving the test. After a thorough study of the methods in use (1), the improved threshold test was selected as being the more sensitive and best adapted for this work. Much of this has already been published (2, 3).

The procedure for conducting the odor tests, known as the threshold method, consists essentially of diluting the sample to be tested with odor-free water to the point where the odor is just detectable. The sensitivity of the test is doubled by the use of a glass nosepiece by means of which the air, after agitation with the water in a covered flask, is conducted to the nostrils with little or no dilution from the surrounding air.

METHOD OF CONDUCTING THE TEST

Five extensively used methods of treatment for odor removal were used as a basis for the experimental work. These consisted of

activated carbon treatment, superchlorination and dechlorination, ozone treatment, ammonia-chlorine treatment, and aeration. The data selected covers a period during the fall and winter of 1935 on the treatment of raw Lake Michigan water when objectionable odors were present due to large numbers of micro-organisms. Most of the tests were conducted in the laboratory, except some of the superchlorination experiments and all of the ozone tests, where the regular experimental plant equipment was used.

As a control test where the laboratory stirring equipment was used in the experiments, a sample of the raw water was coagulated with 10 p.p.m. of aluminum sulfate in 2-liter beakers by stirring with the laboratory stirrer (80 R.P.M.) for 15 min. The coagulated water was then allowed to settle for a short period and filtered through a clean washed cotton plug in a funnel. The odor threshold was then determined on the filtered sample.

In conducting the carbon experiments, measured amounts of the powdered activated material (phenol value 25), were added to the raw water in 2-liter beakers and agitated with the stirring apparatus for 15 minutes. Each suspension was then coagulated with 10 p.p.m. of aluminum sulfate and stirred an additional 15 minutes, after which the suspended material was allowed to settle and the samples filtered through washed cotton plug filters. The amount of odor remaining after such treatment was determined by the threshold test. The times of contact and coagulation of the suspended carbon in the laboratory beakers were determined by comparative tests run at the same time with the regular experimental plant equipment. With equal doses of carbon and a normal operation of the plant, it was possible to determine what reaction time was necessary in the laboratory to give the same odor reduction on the same water. It would be well for every water works operator to so calibrate his laboratory equipment to obtain results comparable with actual operation of his plant.

A standard ozone apparatus was used to treat continuously a stream of raw water at a normal rate of 600 gallons per hour. At this rate the apparatus supplied sufficient ozone to produce a color with ortho-tolidin that was equivalent to about 0.3 p.p.m. of chlorine. Bacteriological tests indicated complete removal of B. coli. The odor threshold was determined on two samples collected at the same time; one allowed to stand 30 minutes before testing, and the other 3 hours in a covered flask. After standing 30 minutes no residual ozone

could be detected with ortho-tolidin and at the end of three hours the residual odor was stabilized with little change thereafter.

The chloramine test was conducted in the laboratory by adding measured quantities of ammonium sulfate solution to 2-liter portions of the raw water in covered flasks, allowing them to stand for 15 minutes before adding the chlorine solution. Each flask was thoroughly shaken after each addition and then allowed to stand for a three hour reaction period before making the threshold test. The

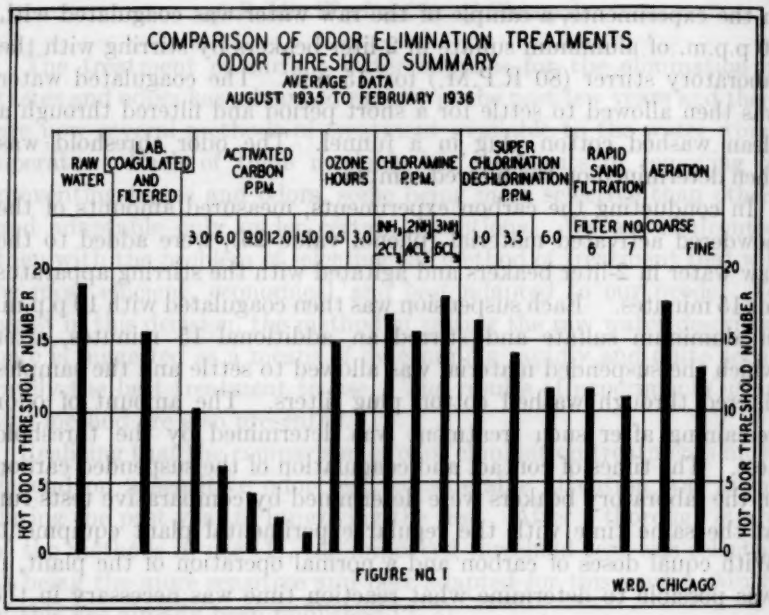


FIG. 1

ratio of one part of ammonia to two parts of chlorine was selected from previous experimental data as being the most effective ratio.

In order to determine how much odor reduction might be obtained with superchlorination alone, 2-liter portions of the raw water were treated in the laboratory with 1.0, 3.5 and 6.0 p.p.m. of chlorine and permitted to stand in covered flasks for 3 hours. Each sample was then dechlorinated with sodium thiosulfate solution and the odor threshold determined. The high dosage of chlorine was perhaps beyond practical limits, but the odor reduction at 1.0 p.p.m. did not provide sufficient data from which to draw a conclusion. Re-

ferring to the summary graph (fig. 1), it seems that the odor producing compounds were quite resistant to change on contact with the amount of chlorine added.

As a second part of this experiment, the regular filter plant equipment was used. The raw water was treated with 12 p.p.m. of aluminum sulfate, mixed in the mixing basin for 35 minutes, and settled for 3.5 hours in the sedimentation basins. The chlorinator was set to apply about 1.2 p.p.m. of chlorine to the water as it entered the sedimentation basin. The filtered water for testing was collected from two of the large portable filters, No. 6 and 7, each having 10 square feet of surface and containing 24 inches of standard filter sand. They were operated at a rate of 2 gallons per square foot per minute. The effluent water contained from 0.6 to 0.8 p.p.m. of chlorine, which was removed with thiosulfate before making the odor test.

The aeration test was conducted with equipment that approximated plant aeration conditions. Part of the test was made with a $\frac{3}{4}$-inch hose attached to the raw water line and pinched together at the end with a clamp to leave an opening $\frac{1}{32}$ inch wide and $1\frac{1}{4}$ inches long. Under sufficient pressure the water emerged from this opening first as a sheet which gradually broke up into large drops. Samples of the aerated water were collected in a large funnel placed at a distance of 10 feet from the nozzle. The water traveled along a curve of about 15 feet.

In the second part of the test, an old fashioned lawn sprinkler was adjusted to throw a spray of smaller drops of water. The travel of the water through the arc was 10 feet and the sample collected in a large funnel as before. The spray from the lawn sprinkler was much finer than could be expected with regular plant aeration equipment, but we were interested in learning what odor reduction a more complete aeration could accomplish. The threshold test was made immediately after the collection of both samples. Because of the low cost of operation, in some cases aeration possibly is a worthy aid in reducing the amount of subsequent treatment by a more efficient method. However, the accompanying data indicates that the proper odor reduction could not be obtained with its use on this particular water.

GENERAL CONCLUSIONS

The results of the actual tests which are shown to illustrate the method of comparing the odor elimination treatments must not be

considered as an exact comparison of these treatments applicable to any water. They are correct for the particular water used in the test at the time and in the manner conducted. The data shows that if the odor threshold is to be reduced to 2, it is quite obvious that activated carbon treatment would probably be selected. It is also evident that a combination of superchlorination and filtration or one of the other treatments would materially reduce the amount of odor to be removed by carbon, so that a combination of two or more treatments may prove to be the most economical in many cases. A complete study of such application has not yet been made.

There is a difference of opinion as to how completely the odor should be removed. When the odor is reduced to a threshold of 2, at a temperature of 70°C., it is doubtful whether any odor will be detected by the consumer. It may not be essential to reduce the odor to this point, especially with an expensive treatment, but it is believed that the hot odor threshold should be as near this point as a reasonable cost for the treatment will permit.

In order to obtain a good comparison of the treatments, it is obvious that the most precise measurement of the odor thresholds must be made, and the task would be quite difficult by any known method other than the one selected. Since the hot odors are more easily detected than the cold odors, the hot odor threshold point being generally three to five times higher than the cold, the graph is plotted according to the results obtained from the hot odor test.

With equipment similar to, and tests conducted in the manner described here, it is possible for any water works operator to determine the most effective treatment to eliminate objectionable odors. The comparison test is of great value where there are frequent or seasonal changes in the character of the water; and when it has been determined by test which method of treatment is the most effective, under the existing conditions, further tests can be confined to a determination of the most effective dosage or rate of application.

SUMMARY

The improved method for a sensitive odor test on water is briefly described.

The comparison of odor elimination treatments may be made on the basis of hot odor threshold determinations before and after treatment.

Procedures are given for making these tests for the comparison of

powdered activated carbon, superchlorination and dechlorination, ozone, ammonia-chlorine, and aeration treatments.

The comparison of a number of treatments by the use of such tests is shown graphically.

(Presented before the Illinois Section, April 11, 1936.)

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GRANULAR ACTIVATED CARBON FILTER PLANT AT CULVER CITY, CALIFORNIA

By C. P. Harnish

(Chief Engineer, Southern California Water Co. of California)

The filters at Culver City, California were designed to eliminate the tastes and odors, and other ill effects resulting from a heavy infection of iron and sulphur bacteria in the underground water supply. The organisms causing the trouble were of the filamentous group of iron bacteria, identified in the laboratory as crenothrix, leptrothrix and cladothrix, accompanied by the sulphur bacteria beggiatoa.

The idea of filtering this otherwise acceptable ground water came reluctantly and only when lesser treatments were found ineffective after many disappointing trials. Activated carbon filters seemed a shorter cut to relief than complete sand filtration as ordinarily practiced. A good strong dose of chlorine could be applied and then the resulting residue of dead organic matter, not oxidized by the chlorine, could be strained out by the filters, with the activated carbon also constituting the dechlorinating agent by reason of its adsorptive powers. All tastes and odors would thus be removed. This was the theory and it was proved to our satisfaction by a small experimental installation at the plant in question.

There is nothing new in the idea of carbon filters. Small household ones used to be very common before public supplies were properly treated. Also, carbon in the form of charcoal was used occasionally in public supplies as far back as 1800. It was not very successful, however, because it lacked adsorptive power, and not until the recent war had any way been found to make it more active. Then carbon was used in gas masks, activated so as to be much more adsorptive than natural chars.

Activated carbon is now used in many water works plants throughout the country to eliminate tastes and odors. Its use has been confined almost exclusively to the powdered form, the powder being added in the preliminary stages of a more or less elaborate water treatment process and then subsequently removed from the water by sand filters. On the other hand, beverage plants and other industries

requiring a water absolutely free from obnoxious tastes, have, within the past few years, installed small filter units packed with activated carbon in the granular form through which the water is passed. The installation in Culver City, therefore, had some precedent, but it is, or was at the time of its installation, one of the very few designed for a public water supply and the only one of its kind on the Pacific Coast.

The filters are of the pressure type which fit in better with the existing layout than those of a gravity type. Existing prior to the installation of filters was a steel tank aerator and sand trap into which the water from the wells was pumped. The aerated water then passed into an adjacent concrete reservoir, or settling basin, with about two hours detention from which booster pumps drew the water and discharged it into the distributing system. The filters were installed at a convenient point on the discharge line from the booster pumps and were designed to handle the normal plant output of 1.25 m.g.d. The arrangement is similar to that utilized for pressure sand filters in swimming pool work so that any one unit can be cut out of service for backwashing, inspection, or repairs, with the other two temporarily taking the full load. Each filter is 10 feet in diameter and approximately the same height, and designed to filter downward at the average rate of 3½ gallons per minute per square foot of surface, with a 33⅓ percent overload possible during short periods. A standard strainer system was used, over which was placed several layers of graded gravel, topped by a 3-inch layer of filter sand and then the bed of granular activated carbon, 42 inches thick. This particular grade was made from Texas lignites. An important factor, particularly stressed by the manufacturer, was the interior coating of the tanks designed to protect the steel surfaces from electrolytic action which results from a highly activated carbon coming in contact with a metallic surface. Backwashing was to be at the rate of 12 gallons per minute per square foot of surface, requiring a total of a little less than 1,000 g.p.m. per unit. The tanks were designed for a working pressure of 150 pounds per square inch, or twice the normal pressure. Each filter was equipped with a Venturi tube and Manometer for indicating the flow passing through, which by means of manually operated, but readily accessible gate valves, could be equalized between the three units. These also indicated the backwash rate.

The filter tanks and necessary accessories were purchased complete

from the manufacturer, the water company's forces making the installation including that of the interior strainer systems, the placing of the aggregate and carbon, and all the piping. The work was completed without any interruptions to the ordinary operation of the plant except for a few hours when connections were made to the main discharge line.

The results obtained from these filters were entirely satisfactory from the moment they were first put into operation in July, 1933, and continued so during the four following months, when the plant was operated almost continuously at full capacity. A chlorine dosage of 4 parts per million was introduced into the steel tank, just after aeration, with a residual chlorine of 2 parts per million carried into the concrete settling basin, and about 0.5 part per million to the filter inlet, which, of course, was all adsorbed by the carbon in the filters. The effluent was a pure, clear, palatable water without any trace of organic taste or odor, nor that of chlorine. Such is the magic of activated carbon. Complaints ceased immediately, a contributing factor being that the mains had already been flushed out and freed from their accumulated deposits. The filters were backwashed once a week, the wash water being run into a small concrete lined sump in order that it might be observed before it was wasted into the adjacent creek, and so that carbon drawn off in washing could be salvaged.

The story cannot end here, however. In November, 1933, after four months of most satisfactory operation, a few complaints about tastes in the water began to appear, which increased in number and intensity week by week. The cause was soon found. The operator in charge of plants in this district had been on vacation, and during his absence, the filters had not been washed with the same conscientious care which he practiced. Inspection disclosed a mat of dead organic matter on top of the carbon which even the most thorough backwashing would not remove. To complicate matters further there was a certain amount of oil mixed up in this mat and in the top layers of the carbon—all in all a sorry mess.

After much study and consultation, upon recommendation of the manufacturer, the filters, one at a time were given a dose of 5 percent caustic soda solution which was allowed to stand overnight. It was thereupon washed out and a 3 percent commercial hydrochloric acid solution applied. The amount of accumulated deposits which this treatment removed was amazing. Even yet, however, it was felt

that the filters were not entirely cleansed and the idea of using air along with the water in backwashing was hit upon, very fortunately as it later appeared.

The water company owns a compressor mounted on a truck and used for pavement breaking, etc. and this was brought into play and hooked up to the backwash line. Then the dirt literally flew out of the filters, but unfortunately some of the carbon did too. However a little experimenting showed just the right proportions of air and water to use to obtain satisfactory washing without losing too much carbon in the process. The filters were now really clean and by continuing to use air in backwashing, it was expected that they could be kept so. The compressor was used regularly thereafter for a number of backwashings and then a rotatory blower, with a capacity of 100 cubic feet per minute, driven by a 7½ H.P. motor, was permanently installed to supply the air. No further trouble has been experienced with the effluent which continues to satisfy, as at first, even the most discriminating taste.

The filters with the original carbon have now (September, 1935) been in service for two years and two months. The manufacturer had guaranteed the effectiveness of the carbon for two years, provided the water was clear and free from foreign substances, and above all, oil. In order to check on its condition at the end of the guaranteed period, typical samples of the mineral were submitted to a laboratory for screen analyses and phenol adsorptiveness.

The carbon had received pretty strenuous treatment and considerable agitation in backwashing, both with air and water, and a certain amount of the material had washed entirely out of the filters into the waste sump, was reclaimed therefrom and put back into use. Some, of course, was lost beyond recall, the total shrinkage being about 25 percent of the original volume. After being subjected to this sort of treatment for over two years it was expected that the crystals might be breaking down and disintegrating more than was apparent to the eye. This proved not to be the case, however.

This speaks surprisingly well for the physical hardihood of the carbon crystals. It also shows that the loss of carbon cannot be accounted for by its slowly being ground into dust and the dust lost in backwashing.

The other analysis run was the relative activity of the carbon measured by phenol adsorption. The average phenol adsorptive capacity of the material tested was 38 percent of that of new material.

In other words 62 percent of the effectiveness of the carbon was lost in some two years service. On the other hand the laboratory reported that after treating the samples with a 10 per cent solution of caustic soda, the adsorptive capacity came up to 50 per cent of that of new. This means that if the foreign matter was removed so that the carbon particles could get a better chance to do their work, only about one-half of the effectiveness had been exhausted in over two years hard service.

Just how long the plant can continue to operate satisfactorily without removing or reactivating the carbon is a matter of conjecture. The carbon can be reactivated at the factory from whence it came and thus be brought back to its original effectiveness at a cost of about one quarter that of new material. Possibly some local means will be found to do the job even cheaper. About 10 percent of the carbon is usually lost during the reactivating process and this loss or shrinkage, together with that lost in the ordinary course of operation, will have to be made up by the purchase of new material. What probably will be done will be to put all the present carbon into two of the tanks, after giving it a bath of caustic soda, and then purchase new carbon for the third unit. In this way it is believed that the reactivating can be postponed for another year and satisfactory results still obtained.

As to costs, the initial installation ran to $10,000.00 in round numbers, exclusive of engineering and overhead, or at the rate of $8,000.00 per m.g.d. capacity. Of this amount, approximately $2,800.00 represented the cost of the carbon itself.

A very rough idea of operating costs may be obtained by first taking the 25 percent of the carbon lost in operation at $700.00 and then, ignoring the fact that it can or probably will be reactivated, charging off 50 percent of the cost of the balance because of exhaustion. The total cost of carbon for the two year odd period would thus be $1,750.00 on this reckoning, or $3.10 per million gallons for the 565,000,000 gallons treated. Other operating costs in connection with the filters have been minor and the foregoing costs could well be assumed to include them. The plant has not had a regular operator, which, it is conceded, may be the principal reason for the loss of carbon, but to compensate for this, no additional operating pay roll has resulted from the installation of the filters, although, naturally, everyone concerned has had some additional duties.

The foregoing costs of carbon treatment cannot be compared

directly with costs of introducing powdered activated carbon at most other filter plants, since these latter costs, of course, are merely incidental to those of complete treatment processes, and many other variable factors enter into the question, not the least of which are interest costs and ideas on depreciation. Measured from the standpoint of results, the costs at this Culver City Plant are considered reasonable.

(Presented before the California Section, October 25, 1935).

THE POSSIBLE EFFECTS OF WILD ANIMALS ON THE BACTERIAL POLLUTION OF WATER

By H. B. Foote

(Director, Division of Water and Sewage, State Board of Health, Helena, Montana)

During the past several years specimens of excreta from various animals have been collected and submitted to tests in the laboratory of the Water and Sewage Division of the State Board of Health. These specimens, for the most part, have been collected on watersheds furnishing public water supplies. The purpose of this study has been to determine, if possible, what influence these animals on the watersheds might have so far as their effect upon the incidence of coli-aerogenes is concerned. There have been times when positive tests for these organisms have been obtained from samples of water taken at such remote places in the mountains as apparently to preclude the possibility of even any domestic animal contamination. While this study might appear, on first thought, to have but an academic interest, we have obtained information which in some instances has clarified an otherwise puzzling situation.

Search of the literature reveals very little, if any, information concerning wild animals as possible sources of these indicative organisms. Usual statements relative to animal pollution of water make no distinction between wild and domestic animals.

At the outset, I should state that but relatively few specimens have been studied so far, and that in the case of some of these the material has become quite dry before it was submitted to the laboratory test. Any results which we have obtained, therefore, are considered rather meager and not sufficient upon which to base definite conclusions. The data are presented, however, in the belief that they are sufficient to show justification for further study, not only in Montana but in other states of similar topography and animal incidence. We hope to continue our studies as time goes on and welcome any criticisms, suggestions, or information already obtained which may be submitted.

The technic which has been used in this study is simple. The specimens taken into the laboratory are opened with a sterilized

TABLE 1

Results of tests

SPECIMEN FROM	NUMBER OF SPECIMENS	ANIMALS WERE	TESTS FOR BACTERIA OF THE COLI-AEROGENES GROUP
Bear	1	Native	+
	1	Native	+
	1	Native	−
Beaver	1	In Captivity	+
	4	Native (water above and below dams)	−
	1	Trapped (specimen from intestine)	+
Bird	1	Native (near Helena)	+
Coyote	1	Native in lower mountains	+
Deer	1	Native (in isolated area)	−
	2	In Captivity (near humans & domestic stock)	+
Elk	1	Native	−
	1	Native (but mingled with domestic stock)	+
	1	Native	−
	1	Native	−
	1	Native (domestic cattle in area)	+
Fish	1	In Contaminated Stream	+
	1	In Spring Water Pond (water contaminated apparently by wild ducks)	−
Gopher (or groundsquirrel)	1	Native	−
	1	Native (by public roadway)	+
Marmot (woodchuck or groundhog)	1	Native (found burrowing in privy pit)	+
	1	Native	+
	1	Native (near hotel in Yellowstone Park)	+
	1	Native (near roadway and pasture)	+
Moose	1	Native (in isolated areas)	−
	2	Native (in isolated areas)	−
Porcupine	1	Native (in isolated area)	−
	1	Native (in isolated area)	+
	2	Native (in isolated area)	+
	1	Native (cattle in this area)	+
Prairie dog	1	Native in Field	−
Rabbit	1	Native	−

instrument. From the freshly exposed surface, some of the material is withdrawn with a tool or instrument which has also been sterilized and which is suitable, depending upon the consistency of the material. Usually forceps or a needle is adequate. We feel that the material, taken thus and not affected by the external conditions which may have affected the surface of the specimens, should give us reliable data as to the contents.

The specimen, taken as described above, is introduced directly into a tube of standard nutrient lactose broth and incubated under the usual conditions of temperature. Any fermentation of gas is noted at the end of twenty-four hours and also again at the end of forty-eight hours, and wherever gas is produced—even in slight amounts—streaking is made on Endo's medium. Typical colonies on such plates are called positive, no further confirmatory tests being made except in case of doubtful identity.

Table 1 shows the sources of the specimens and the results which were obtained from their tests. Thirty-seven specimens collected from thirteen species were examined.

We have been impressed with the fact that if the animal being studied is herbivorous, has cleanly habits, tends to stay aloof from other animals, and especially from human habitations, it is not a factor in the introduction of bacteria of the coli-aerogenes group into the water. This is illustrated by the results obtained from specimens from moose and deer, especially deer which are found in their native state and habitat. On the other hand, if the animal is a scavenger or less cleanly in its habits, it probably will excrete the organisms. This is illustrated in the results obtained from the bear, woodchuck or marmot, and coyote.

It is interesting to note that our studies of water in which beaver are native usually show no change or difference in the coli content above their ponds and below them, whereas beaver in captivity excrete great numbers of these organisms. In the same way, we observed, deer droppings found on the hillsides in remote areas gave negative results while droppings from captive deer in pens near domestic stock and habitations showed an abundance of coli-aerogenes bacteria.

Thus it seems that wild animals can harbor and excrete organisms of the coli-aerogenes group, but that they do not necessarily always do so.

(*Presented before the Montana Section, April 17, 1936.*)

CROSS-CONNECTIONS AT HOUSTON, TEXAS

By Clyde R. Harvill

(Sanitary Engineer, Water Department, Houston, Texas)

The subject of cross-connections in Houston was discussed in several conversations with representatives of the State Department of Health prior to June, 1929. Up to that time nothing of a concrete nature was done towards eliminating them. In the early part of June, 1929, one of the main pumping plants in the water system was disabled. It was flooded with some 20 feet of water due to an unusual amount of rainfall on the upper portion of Buffalo Bayou. The plant which was out of service furnishes the down town section of the city under ordinary conditions and thus it became necessary to urgently request, through the press, that owners of private well water supplies turn their water into the city system. It was soon determined that a number of these supplies was of a questionable sanitary quality. The City Health Officer, in order to take proper steps to protect the public, advised that all water used for drinking purposes be boiled. At this time some eighteen private supplies were connected to and supplemented the city supply. At a later date it was found that the total amount from these eighteen supplies were slightly less than 2,000,000 gallons per day. The use of these supplies in the emergency resulted in the State Department of Health recommending that all cross-connections to the public water supply system be eliminated as soon as possible.

At the beginning of this work the most generous estimate on the number of cross-connections likely in existence was 25 or 30. The Water Department immediately began making cross-connection surveys and after some fifty-three had been made this work was temporarily held in abeyance until a study was made of the types of connections found to be in existence and uniform methods of eliminating them could be worked out. Upon investigation it was deemed advisable to draw up a cross connection ordinance which would cover the types of connections found to exist and provide a manner in which these could be eliminated. This Ordinance was passed by

the City Council on March 4, 1930. To the present time it has not been necessary to resort to the courts in the enforcement of this ordinance and we have had complete coöperation from practically every property owner in the elimination of these dangerous connections.

The types of connections found include private well supplies; connections to the Bayou, below disposal plants, for fire protection purposes. Since December, 1930, one man has spent practically his entire time on the making of surveys and re-surveys, the prevention and elimination of cross-connections and other related sanitary work.

The number of cross-connections found in Houston is probably larger due to the easily available water supply at relatively shallow depth in wells within the city. The method of eliminating cross-connections found has been one of the following three methods:

I. Complete severance from the city system and discharging water from the public supply over the top of surge tank.

II. The removal of a section of the line from the city supply and the city placing a seal on both the control valve and the flange connection required to make the public supply available.

III. The complete and continuous chlorination of all water pumped from the private supply, supervision over this supply being turned over to the City Water Department, whereby, the treating equipment is checked weekly by department representatives and daily collection of samples from the private supply for examination in the Water Department Laboratory is maintained. In the latter case, we have permitted chlorination of private supplies in only three instances.

To the first of October 1935, we had made 211 cross-connections surveys, 132 re-surveys where surveys had been previously made, and 134 eliminations had been secured where cross-connections were found to exist. No records have been kept on the number of cross-connections prevented where advance notice was obtained of the owner's intentions to cross-connect to the public supply. After discussion with the owner these connections were not made.

We have found it not only desirable, but necessary to maintain complete information on each survey so that after an elapse of several months we could readily refer to our records and thus prevent cross-connections from being made or to advise owners as to changes in their private system arrangement.

We have begun a study on faulty plumbing found in older buildings and particularly of that within hospitals. Practically all of the hospital equipment manufactured prior to 1928 was found to be a potential hazard both to patients within the hospital and to the public water supply system in the vicinity. Equipment manufactured since that time has been adequately protected from these serious hazards. In regard to faulty plumbing within buildings, we have cooperated closely with the plumbing inspectors and side spud water closets are no longer permitted to be installed, and all new plumbing fixtures with flushometer attachments are required to have an approved vacuum breaker. It will be of interest to know that in the remodeling of a large building new plumbing fixtures were being installed throughout and these fixtures were found to be of the side spud type. They were required to remove the fixtures after they had been installed and upon tracing these fixtures it was found that they had been sent to several other cities within the United States and they also had not been permitted to be installed. It was clearly a case of the manufacturer getting rid of fixtures which were being rapidly outlawed throughout the country.

From the experience we have had in Houston, and we believe ours is of no difference from that in existence in any other major city, we have found that continuous vigilance is necessary in order to properly protect a major water supply from all types of undesirable connections.

(*Presented before the Southwest Section, October 16, 1935.*)

QUASI PUBLIC WATER SUPPLIES AND CROSS CONNECTIONS WITH MUNICIPAL WATER SUPPLIES

By Alfred H. Fletcher

(Sanitary Engineer, City Health Department, Memphis, Tennessee)

BRIEF HISTORY

The rapid drop in the typhoid fever mortality rate throughout the United States during the past thirty-five years has influenced the general public, health workers and water works officials in feeling that the modern treatment plants for the purification of public water supplies had solved the problem of water-borne disease control.

There have been papers and reports for the past fifteen years, or more, by a number of health and water works officials, who have been urging, as the opportunity arose, that the public health hazards of cross connections between municipal water supplies and non-potable private supplies, in many cities, be recognized, and that steps be taken to correct the situation. For the past ten years, committee reports and papers have brought this more and more to the attention of health and water supply workers.

During the decade, 1920 to 1929 inclusive (1), according to Wolman and Gorman, 242 outbreaks of typhoid fever and dysentery, traced to water supplies, have been recorded. These 242 outbreaks resulted in 630 deaths from typhoid fever; over 9,000 cases of typhoid fever, and, over 8,000 cases of dysentery. This record is made in a decade in which sufficient knowledge was available for adequate purification of water supplies and for the proper protection of these supplies against certain hazards that could be controlled. Nearly 45 percent of the water-borne outbreaks during this ten-year period, in the United States, were due to contamination of the water after it had left the treatment plant as safe water and while in the mains enroute to the ultimate consumer.

Gorman writes in a recent paper (2) that during the last two years Chicago has experienced five outbreaks of water-borne illnesses resulting on the basis of conservative figures, in approximately 75 deaths; illness of about 1,665 persons, and, causing several thousands

to become infested with endamaeba histolytica. These outbreaks occurred on premises where dual water systems existed, and four out of the five outbreaks were due to cross connections.

For many years the hidden danger lurking in cross connections between the presumably safe public water supply and some private or quasi public water supply, all too frequently unprotected, or actually polluted, has been recognized. It is only comparatively recently, however, that effective steps have been taken to correct this situation. In many communities such cross connections are being sought out and are either being eliminated, the private supply properly protected, or, the hazard reduced by the use of check valves or other barrier devices.

The responsibility of the local Health Departments for the protection of quasi public water supplies, and the joint responsibility of the Water Departments and the Health Departments for the protection of the distribution system of our municipal water supplies should be recognized and steps should be taken by local Health Officials to bring this about.

DEFINITIONS

The term "cross connection" is sometimes used to indicate a physical connection by means of which water may flow between a definitely *non-potable* source and a public or quasi public potable supply. This definition was used in the first part of a Report by (3) Committee Number 8, of the American Water Works Association on Cross Connections in 1932.

In Memphis, less than ten years ago, the Water Department filed a written statement with the State Health Department that there were no cross connections with the municipal supply. Undoubtedly, this definition above was used, as the Memphis Water Department did not allow cross connections with river supplies that are admittedly heavily polluted.

In our Memphis program (4) a cross connection is defined as:

> Any physical connection whereby a potable water supply system whether public or private, is connected with *another water supply* system either inside or outside of any building or buildings, in such manner that a flow of water into the first potable supply is possible, either through the manipulation of valves or because of ineffective check or back pressure valves, or for any other cause.

The term "quasi public water supply" is defined as:

> Any water supply used or made available by a person, firm or corporation, to their employees, tenants, members, or guests for drinking, or, in connection with the manufacturing or handling of ice, foods, or drinks, such as: candy, ice cream, milk, ice, bottled drinks and any other food or drink products. The source of a quasi public water supply may be a private well or the city water supply.

EXTENT OF PROBLEM

C. G. Hyde (5) uses the following example, which may or may not be typical of the magnitude of the problem of cross connections. In a group of Western cities, constituting a water supply district with a population of about 460,000, a survey of cross connections revealed the fact that there were 2,000 secondary supplies, 408 of which were cross connected with the public supply.

Harvill states that, in Houston, Texas (6), in 1929, due to a temporary shut-down of one of the main pumping plants which furnished the downtown section of the city, it became necessary to request the owners of private well water supplies that were cross connected with the city water supply to turn their water into the city system. This amounted to approximately two million gallons of water per day from eighteen supplies. No information was available at the time however, as to how many supplies there were, the number of gallons pumped per day, and as to the safety of the supplies. It was therefore, urged at the time, by the City Health Officer, that all water used for drinking purposes be boiled. Several of these supplies were found later to be of a questionable quality, and steps were immediately taken to supervise all cross connections.

During the past three and one-half years, in Memphis, working in coöperation with the Water Department on a survey and correction program, cross connections have been uncovered between the municipal water supply and 75 quasi public water supplies. Twenty-seven of these have been eliminated in the following ways. Five plants using their own private supplies were abandoned; 7 plants discontinued their private supplies when pressed for improvements; 8 continued using both supplies, but received the city water over the top of a reservoir so as to eliminate any possible reversal of flow; and, 2 discontinued the city supply. A number have disconnected the cross connection and sealed the city line with a plug and seal, and a

tag reminding the plant that only the Water Department should remove the seal.

REASONS FOR CROSS CONNECTIONS

There are several general or fundamental reasons for the existence of cross connections that may be listed as follows:

1. Cost of public supply for industrial uses, such as: boiler feed, condensers and certain industrial processes, swimming pools, etc.
2. For fire protection:
   a. Possibility of interruptions and failures of public supply. Probably the strongest reason for cross connections is the importance of guarding against the failure of the water supply at times of fire. A failure of supply when fire occurs may well be a disaster resulting in loss of life and property.
3. Inadequacy of public supply.
4. Inadequacy of private supply.
5. Convenience, carelessness or ignorance.

INDIFFERENCE TO RESPONSIBILITIES

Most of us have been assuming, until recently, that the State Health Departments through their Division of Engineering were supervising the various local water supplies through a state-wide supervisory program, including the certification of water for use on interstate carriers. The Municipal Water Departments and Health Departments have been assuming, in many cases, that as the public water supply meets the approval of the State Health Department as to source and purification plant, they could more or less cease to worry about it except for the routine annual or semi-annual inspections.

The questions of source and purification of the water supply for most of the larger cities of the country have been placed under adequate control, but the protection of the distribution systems of our larger city water supplies has been shown to have been somewhat overlooked.

STATEMENT OF THE PROBLEM

In Memphis, the Health Department is recognizing the responsibility, first, of preventing cross connections with river, surface or

other non-potable water; second, of protecting the distribution system of the municipal supply by supervising the source, treatment, storage, use and distribution of private potable cross connected water supplies, as well as, third, of protecting the source, treatment, storage and distribution of all quasi public water supplies that are used for drinking even though not cross connected. The last problem is really divided into two classes: (*a*) a quasi public supply using city water, and (*b*) a quasi public supply using a private source. The Health Officer has the prime responsibility for the supervision of all these problems, as he can insist on the elimination of potentially dangerous conditions and the exercise of the necessary precautionary control measures, provide reasonable inspection, and see that recognized standards of performance are enforced, on private as well as public property.

In Memphis, practically all of the water used, both in the public water supply and for all of the private, or so-called quasi public supplies is taken from a strata of water from 350 to 500 feet deep, which is a pure supply. It does not seem reasonable, from a public health standpoint, to require a complete severance of all cross connections or to prohibit new cross connections between potable supplies.

The problems involved in protecting the distribution system of a municipal water supply are similar to the problems of protecting all quasi water supplies. Some of the hotels, office buildings and industrial plants take city water, using it for condensing purposes; or store it in improperly protected underground reservoirs; or aerate it in alleyways and under roofs subjecting it to roof wash and other contamination; or store it in elevated tanks unprotected from various sources of contamination; or cross connect it to the recirculating system of a swimming pool; and then use or reuse this water for general domestic purposes within the building. Some of the reservoirs were built partly under the city sidewalks or under driveways with loose manhole covers which permitted sidewalk and driveway wash water to run directly into the drinking supply.

SUMMARY OF SITUATION IN MEMPHIS

The summary of the situation in Memphis of supervising the distribution system of the public water supply and the entire system of quasi public water supplies, even though not cross connected,

may be outlined as follows: 50 percent of the total investment in the public water supply of Memphis is in the distribution system, amounting to about $5,000,000.00. To this can be added the distribution systems of all quasi public water supplies cross connected with the municipal supply, together with the distribution system on private premises using city water.

The quasi public private source water supplies cross connected with the city supply can actually be considered a part of the municipal water supply. There is nothing separating the two but valves. The total daily pumpage of water by the 48 supplies cross connected with the city, is approximately 7,775,000 gallons. It is estimated that approximately 20,000 people drink from these supplies daily.

At one of the cross connected water supplies, for example, there is a total of one and one-half miles of distributing mains to the various buildings of that concern. Another figure which might be used to emphasize the extent of the problem is that in one hotel in Memphis, the cost of installing the plumbing pipes and fixtures was in excess of a quarter of a million dollars.

The Memphis public supply pumps approximately 20,000,000 gallons daily under normal conditions, while all the quasi public private source water supplies of the city pump approximately 40,000,000 gallons of water daily.

There are now 143 quasi public private source water supplies listed in our files, and 108 of these supplies are used for drinking purposes, by approximately 35,000 people. These 108 drinking water supplies pump approximately 35,000,000 gallons of water daily. During this past year 6 new wells have been constructed while 14 have been abandoned, according to our records.

An ordinance was drawn and jointly recommended by the Health and Water Departments to the City Commission for adoption. It was adopted on June 4, 1935. The Ordinance is "To Regulate Quasi Public Water Supplies and Cross Connestions with the City Water Supply."

The plan developed for supervising the quasi public water supplies in Memphis is as follows:

1. A master survey sheet is made out on each supply. This sheet covers more or less detailed information under the following headings: (a) source; (b) pumping plant; (c) treatment; (d) disinfecting equipment; (e) chemical solution tanks; (f) filters, (g) service pumps;

(h) water storage; (i) elevated tank; (j) coagulating basins; (k) distribution system.

2. Monthly visits are made to each cross connected supply and to each quasi public water supply used for drinking water. Samples are collected at this time, but only casual inspection made. Reports of the results of the laboratory tests are mailed to the owners of the supplies on a printed form. In case of contaminated samples, further inspections and laboratory tests are made. The Water Department is furnished with this information for all cross connected supplies.

3. During the Fall and Winter months of each year, a careful inspection is made of each supply and a letter is written approving the supply or, calling their attention to necessary improvements or corrections. Follow-up visits are made on unapproved supplies each year until all supplies are satisfactory in every detail as noted by the Inspector.

4. Copies of all letters regarding cross connected supplies as well as copies of all unsatisfactory laboratory reports are sent to the Water Department for their files.

The question of cross connections between a drinking, or potable water supply, and waste water, or sewer pipes, has not been mentioned in the discussion. There is universal agreement of course, that these should not be tolerated and every effort should be made by Public Health and Water Works Officials, and owners and operators of all quasi water supplies to eliminate all existing connections and prevent any future connections.

It is vitally important that water supply superintendents and municipal public health engineers work together for the protection of the water supply in the distribution system.

In closing, the problem of cross connections through plumbing fixtures should be mentioned. This phase of the problem is not as easy to solve as the type discussed in this paper. It involves the education of plumbing fixture manufacturers, plumbers, health officials, public health officials, engineers and architects. It also calls for extensive research work, adoption of ordinances, inspections, condemnation of, or properly equipping existing plumbing fixtures, etc. It might be considered the second phase of a complete cross connection and quasi public water supply protection program, and should be made a part of the building, plumbing, and housing codes of all cities.

SUMMARY

1. The rapid decrease in typhoid deaths throughout the United States resulted in a false sense of security on the part of Public Health and Water Works Officials.

2. Numerous outbreaks of water-borne infections has stimulated a widespread interest in cross connections.

3. Local surveys are indicating that the problem of cross connections is much larger than usually anticipated.

4. Cross connections are sometimes necessary and with potable supplies and proper supervision are feasible and safe.

5. Memphis has developed a program including the adoption of an Ordinance to supervise quasi water supplies and cross connections between the public supply and some 48 potable quasi public supplies.

6. Cross connections between drinking or potable supplies and waste water, or sewer pipes, should be searched for and not tolerated by public officials and quasi public water supply owners and operators.

7. Cross connection through plumbing fixtures is important and might be considered the second phase of a complete cross connection and quasi public water supply protection program.

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(4) Ordinance, "To Regulate Quasi Public Water Supplies and Cross Connections with the City Water Supply," City of Memphis. Adopted, June 4, 1935.

(5) Recent Trends in Sewerage and Sewage Treatment. Charles Gilman Hyde. Municipal Sanitation, Vol. 7, No. 2, February 1936.

(6) Cross Connections at Houston, Texas. Clyde R. Harvill. Jour. Amer. W. W. Assoc., Vol. 29, No. 1, January 1937.

DISCUSSION

L. S. VANCE (*Principal Assistant Engineer, Louisville Water Company*): In 1929, the following relatively strict regulation was adopted by the Board of Water Works of the Louisville Water Company:

Foreign Supplies

The water from the Louisville Water Company's system shall not be supplied to any premises where the pipes used to convey or distribute water from the Water Company's system are so connected, either directly or indirectly, as to receive a possible water supply from any source other than that furnished by the Louisville Water Works.

Whenever any physical connection, direct or indirect, is found to exist or to be liable between any private water system and the Louisville Water Company's system, the Louisville Water Company's supply will be shut off from the premises forthwith. Provision for a removable nipple will be considered a physical connection and does not meet the requirements contained herein.

Except that where dual supplies are necessary or desired, lines carrying the water from the Louisville Water Company's system must be protected against back flow of possible polluted water by an atmospheric gap of not less than six inches. This may be accomplished through an elevated tank with or without a booster pump, or an open cistern with booster pump. In every case the inlet to the tank from the line carrying water from the Louisville Water Company's system shall discharge at least six inches above the maximum possible high water level of the tank or cistern as the case may be.

This regulation was formulated only after considerable study of existing similar regulations of other states and cities. Its adoption was at the earnest instigation and with the whole hearted recommendation of the State Board of Health of Kentucky.

As a further protection of the water supply a regulation was later adopted which prohibited the use of water fixtures "which in the opinion of the Water Company are of a design which may create a hazard from a sanitary standpoint."

The enforcement of such regulation is very difficult except with the full coöperation of all interested agencies. In Louisville, we had from the start, of course, the fullest coöperation of the State Board of Health. The continuous and regular inspection by their various departments of the plants and industries under their supervision was invaluable. Later the coöperation and backing of the City Health Department, the building and plumbing inspectors, the Master Plumbers' Association, the Kentucky Actuarial Bureau and the Mutual Fire Insurance Companies was obtained. With such coöperation the problem resolved itself practically into the elimination of existing unapproved connections, in that new connections in violation of the regulation were most unlikely to be installed.

The following examples of unapproved existing connections and the methods of their elimination will serve to show the hazards to a

public water supply which can exist un-noticed and unsuspected and cannot be detected except by specific and detailed inspection.

Plant "A" had private fire protection and automatic sprinkler system. Primary source of water supply was connection to city mains, secondary source of supply was a fire pump drawing water from 200,000 gallons open concrete reservoir kept filled with roof drainage water. (Note: Open reservoir was used during some seasons of the year as an unapproved swimming pool by small boys of the neighborhood.) Discharge pressure of this fire pump higher than static pressure in city mains, so that during periodic test operation a leaking check valve would have allowed contamination of the city supply. Elimination of the hazard was accomplished by abandonment of reservoir and construction of a steel ground level tank filled with water from city mains as a suction supply for the fire pump.

A considerable number of plants with existing well supplies in addition to a water supply from the city mains maintained cross connections between piping systems in order that a supply could be obtained from either source. The only approved solution for such an arrangement was the complete elimination of any pipe connections between the two systems and also the elimination of any provisions for a removable nipple connection. A swinging nipple connection, allowing the inside plant piping system to be connected *either* to the well pipe *or* to the Water Company's service pipe, *but not* to both simultaneously, would be approved. Through this arrangement a very large number of the probable and possible cross connections were eliminated.

Plant "B" had an Automatic Sprinkler Fire Protection System with the primary source of supply a connection to the city mains; secondary source of supply was an elevated tank. A deep well supplied water for cooling and condensing purposes and some process washing within the plant. The upper half of the sprinkler system elevated tank was used for pressure storage for the well supply system. This created a direct cross connection between the well water and the city supply. Recommended solution was a separate elevated tank or pneumatic tank for well supply pressure storage. In lieu of this construction, permission was reluctantly given for the installation of a false bottom in the existing elevated tank to separate definitely the well water from the city water. This change, however, has not yet been accomplished.

Office Building "C." A shallow sewer connection required that sewage and drainage from the basement and first floor be pumped by a sewer pump in sub-basement, with electric motor driven centrifugal pumps. A direct connection from piping carrying city water to the top of the pump casing to prime the pump had been installed. It would have been possible, under certain conditions, to pump sewage into the city water mains.

Drug Store "D." Due to the installation of the drain from the soda fountain wash sink on a very flat grade through the basement, and in order to clear frequent stoppages in this drain, a water jet nozzle was installed with direct connection to the city water pipes. Under certain conditions raw sewage could be syphoned back into the city mains.

Photographer's Shop "E." The washing trays of almost all photographers were equipped with a rubber hose on the inlet pipe to obtain an under-water inlet so that the turbulence of the entering water would not damage the negatives or prints being washed. Conditions of very low pressure caused by pipe line breaks or very heavy concentrated water demand could easily syphon the water from the tray back into the pipe system.

Private swimming pools, fish ponds and lily pools were almost universally equipped with submerged inlets. The requirement of, at least, a six inch air gap between the inlet pipe level and the overflow lever was strictly enforced.

The elimination of such dangerous situations is anything but a pleasant task and requires the use of the diplomacy of an ambassador, the bluffing ability of a poker player and the convincing talk of a super salesman. But the feeling of relief from the ever present danger as the program progresses successfully and the bad situations are removed one by one more than pays for the effort and tenacity of purpose required.

(*Presented before the Kentucky-Tennessee section, March 24, 1936.*)

THE CONSTRUCTION OF GRAVEL WALL WELLS

By R. R. Schweitzer

(President, Layne-Atlantic Company, Norfolk, Virginia)

There are nearly 12,000 public water supplies in the United States and at least 65 percent of these are derived from wells. Many of the larger cities which get their primary supplies from surface sources augment these supplies from wells.

Cities such as Los Angeles and New York use over 100,000,000 gallons per day from wells either as a definite separate supply or to augment their supply during seasonal peak load conditions. The west end of Long Island alone is supplied by wells for public and private consumption with over 200,000,000 gallons per day. Literally, thousands of the industries that are using large water supplies are using well supplies and if we added to this the several millions of farm wells and individual owners that are getting their supply from underground sources, more water is used from the ground for domestic and industrial purposes than from the surface. The methods and means of its recovery and treatment merit the study and consideration of all the engineers and the water works fraternity.

Strangely enough, regardless of the centuries during which water has been obtained from wells, very little was done to improve the methods of ground water recovery used by Moses and his spring pole drill, as we find instances of its use today, and it is only during the past half a century that much progress has been made. Much of this progress has been made in the past five or ten years. This is because the engineers specializing in public and private water supplies have begun to realize that the ground water sources of supply are really worth while and are more meritorious and deserve more attention than it was thought by the prominent engineers of previous generations. Many cases of the most noted engineers of their time are on record where their opinion was given that ground water supplies for certain areas were inadequate, that they were liable to become exhausted or to turn hard or change in characteristics after a short time, but hardy and confident pioneers installed large well systems in

spite of such obstacles, and actual use over long periods of years have shown these opinions were erroneous.

ADVANCE STUDY NECESSARY

This should not be construed, however, to mean that ground water supplies cannot be overtaxed and it should be understood the supply is limited in any given territory, but that this limit varies with conditions. There are many notable cases especially in the irrigation fields where the supply has been greatly over-estimated. Careful and adequate study of all features entering into the problem should be made and there should be no need whatever of disappointment in the quantity or quality of water capable of being recovered and the method and cost of treating.

After the adequacy of the sources of supply and their dependability has been determined, the items in which this group of superintendents and engineers is interested, are the safeness of the supply, and the most efficient means of recovery. These two things depend upon the mechanical construction of the well, the geological formations penetrated, distance from intake, purity of the water at the intake, kind and amount of natural filtration in reaching the well site, and the area in which the well is located.

It has almost been the custom in the past to draw specifications for a small town water supply well somewhat as follows:

"A 10-inch standard drive pipe weighing 60 pounds per foot with heavy drive couplings, on the bottom of which is placed a 10-inch heavy steel cutting shoe, shall be used. This pipe shall be driven and drilled down to a depth not less than 100 feet (usually 100 feet being acceptable) or driven to the water bearing formation. A screen of suitable openings shall then be placed through the water bearing formations and be sealed in an approved manner to this casing." That is supposed to be a well. If the casing is tight, that is, the screwed joints do not leak, and if there is sufficient thickness, it has been considered safe.

DIFFICULTIES IN DRILLING

No well driller can drive a pipe through various soils, sand, rock and other formations to any considerable depth unless the cutting shoe as specified on the bottom cuts a larger hole than the casing itself so that the skin friction is removed from the outside of the casing. No one knows this better than foundation engineers driving

piling. If this shoe is landed in the water bearing formation even though that may be found several hundred feet below the surface, there has been opened up through impervious clay strata, sands, etc., an open passage from ½ to 2 inches in width completely surrounding the casing. This in itself may develop into a continuous source of contamination from the surface or from some contaminated source between the surface and the bottom. When casings are set with standard cable tool or percussion rigs they cannot be sealed in this space. It is too narrow to put sealing material down from the top without arching and clogging before it reaches the bottom. Several feet of cement around the top or mounding the ground around the casing is not an adequate protection. Contamination may enter a number of feet from the well into the sand strata that dip from the surface to around the casing at a number of feet below the casing top and follow the casing down. The soils in their original state, even if there is only a relatively few feet of impervious clays, will without question prevent contamination reaching the source of the later supply but if this is broken in setting the casing and the space filled water with anything pervious, like sand, and that is about all that can be worked into such space, it vitiates all other precautions.

In oil field construction for years it has been the custom to cement off water bearing formations by the use of various means. If it is desirable and possible to keep water from entering into oil why should not similar methods be used in securely sealing the casing to the formations in such manner that there is no chance of contaminated water following the casing to the source of water supply?

CEMENTING OF CASINGS

A number of state and city boards of health have realized this situation and have insisted on complete cementing of casings. Usually this has been between an inner and outer casing where the mud rotary process has been used to set outer casings and the outer casing has been set in heavy drilling fluid or mud. In this manner there is no question but that an impenetrable mass has been placed between the native formations and the casing and this results in a perfect clay seal if carefully done. If, however, quantities of sand and gravel are mixed, it is possible for "threads" to follow down the casing and open channels especially in the case of the more shallow wells.

In the case of the City of Savannah, and in several other parts of

the country, methods and means have been devised of cementing with a pure Portland cement grout all of the space between the outer casing and the native formations making a seal 100 per cent perfect, leaving no opportunity at any point of water even reaching the casing to cause future corrosion or to prevent "threading" of contaminated waters to the bottom. In the City of Savannah well, 100 feet of 30-inch casing was set concentrically in a 34-inch diameter hole. Connections were made in such manner that clear water was pumped from the bottom up all around the casing until the space between the casing and the native materials was completely washed free of drilling muds. When this condition was attained, cement was pumped from the bottom of the casing through the same apparatus until the cement grout flowed up and securely sealed the space. After this was completed a 28-inch hole was drilled from the bottom of the 30-inch casing to a depth of 245 feet into the hard limestone cat at that horizon. A 24-inch casing was set concentrically in the 28-inch hole and extended through the 30-inch to the surface of the ground. Clear water was pumped through from the bottom of the 245 feet of the 24-inch casing to the surface until the space was thoroughly cleaned. Cement was then pumped in at the bottom of the 24-inch casing until it rose and discharged between the 24- and 30-inch casing completely cementing with a pure cement grout the space between the 24-and 30-inch and cementing the 24-inch casing into the hard limestone cap rock and to the native soil from 100 to 245 feet. A 20-inch hole was then drilled through the water bearing limestone rock to 585 feet. A duplicate of this well is now being drilled for the Union Bag Corporation in Savannah.

It is believed that the several thousand dollars additional cost for this cementing protection will be more than repaid to the city in the security against contamination through possible corrosion of casing in the future as they now have a 30-inch casing embedded on both sides for 100 feet in a pure cement grout and a 24-inch casing lying inside of the 2-inch cement wall. As far as it is known this should be permanent construction. It is safe from contamination.

In some areas where gravel wall wells or gravel pack wells are used, the same method is being followed in recent years. The outer casing is cemented to the ground formations and the space between the well tube proper and the outer casing is cemented after the gravel has been placed. When this system is used it is necessary that the gravel is placed in such manner that there will be no need of additional gravel at any time in the future.

UNDER-REAMING—A NEW DEVELOPMENT

This brings us to the latest development in gravel wall wells. The perfect gravel wall well is the well which will be constructed of permanent materials, be secure against contamination, and will have a sufficient body of the proper size gravel to retain the native sands in their original position without permitting an incursion of the sand grains in the interstices of the gravel when pumping the maximum capacity of the water bearing strata. The largest possible body of gravel must be placed around the well screen, in order to obtain the most economical and best results. An outer casing may be large enough to permit the installation of an inner casing, if two casings are required, and large enough for an efficient pump, but this may not be of sufficient diameter to permit the introduction of enough gravel to obtain the desired results, a maximum capacity of sand free water.

There may be many or only one water bearing horizon and the cost of a large hole and casing through all formations may be prohibitive. Two systems of attempting to obtain a sufficient size hole through the water bearing formations have been quite thoroughly developed. The older, in use some 25 years or more, is agitation or what is commonly termed hydraulicing. The other and more recently developed method under-reaming.

In the latter, or under-reaming method, again two systems have been quite efficiently used. The one is to have expanding reamer blades that will extend out and cut out the water bearing formations mechanically. The second is by hydraulically jetting or undermining the formations or a combination of both. These processes of under-reaming naturally carry considerable construction risks, and require considerable experience on the part of the contractor. Every individual case is a real engineering problem and needs to be studied and treated with the proper means applicable to the conditions found. Fundamental or underlying principles must be kept in mind and followed if success is to be had with gravel screened wells of this type. Success with gravel wall wells meaning not only to get a supply of sand free water but to get from two to ten times as much as can be had from common screened wells where the metal screen is in direct contact with the natural formation.

In a gravel wall well the metal screen diameter needs to be only sufficient at the various points to carry the total amount of water passing that point without undue friction. Fifty feet of screen in a

well producing 1500 to 2000 g.p.m. can be made up with the lower 20 feet 8 inches in diameter and the next 20 feet 10 inches in diameter and the top 10 feet 12 inches in diameter providing of course the water bearing characteristics of the strata are fairly uniform. A well of 1200 gallon capacity per minute or less can be screened throughout with 8-inch screen, and no serious loss sustained.

CARE NECESSARY IN SELECTING SCREENS

Screen material in order to add permanency to the well should be of the very best grade of non-corrosive metals, such as silicon-manganese-bronze or the various stainless steels. Iron screens of any of the lower priced copper bearing metals can be safely used where the water is free of CO_2 or dissolved oxygen and other corrosive gases or elements in the water. Cast iron or concrete screens can be used in shallow wells. Iron screens of any kind other than stainless steel should not be used where carbon dioxide, dissolved oxygen, sulphuretted hydrogen, or other corrosive materials are found in the waters in any appreciable quantities. Screening metals of a composition, even though in large part copper, should not be used, if the balance in the materials is such as to create electrolytic action or electrolysis on either the well casing or the pumping equipment installed in the well. Screens made up of 90 to 94 percent copper, the balance silicon and manganese, are from experience probably one of the best screening materials to use under nearly all conditions with the possible exception of water containing sulphur when stainless steels may prove and are claimed by some authorities to be superior.

The openings in the screen should be large enough so that they will just safely support the screening gravel materials, thereby giving free access from the gravel envelope into the well tube through the screen. The gravel envelope should be under no circumstances less than eight inches in thickness and should always be sufficient in its outer periphery so that the velocity of the water will be low enough so that it does not move the native sands.

THE GRAVEL WALL

Mechanical under-reaming provides a uniform hole through all formations and while this does not have any disadvantage provided the diameter is great enough to sustain the sand in the loosest and finest formations (that is, there is no objection to a large hole through hard cemented or clay bearing sands) neither is it of any particular

advantage as these formations in their cemented or clay containing conditions, yield very much less water than the finer more uniform sands which are loose and clean or relatively so. The greater portions of water enter through the cleaner and more uniform sands, and the velocity through the gravel envelope is much higher at that horizon. The finer grains of sand also move more readily, therefore it is extremely desirable to have as large a diameter excavated in these finer sand formations as possible. In fact it is necessary. If the envelope is too thin at these high velocity points and there is not sufficient body of gravel above to move immediately into the space left by the sands as they come in, a constant infiltration of sands through the gravel will take place. If the gravel envelope is thin but of small enough size grains to prevent this, the supply taken from these sands is limited for the reason that the well is of smaller diameter. If the metal screen is fine enough to retain the sands which flow through the gravel then in a short time the gravel wall loses its effectiveness and we have nothing more than a sand screened well as all of the interstices and open spaces between the gravel grains are filled with finer sand grains. When this condition is true up to and against the screen, as in a sand screened well, the velocity through these portions becomes excessively high and, as the frictions increase according to the square of the velocity, if the well is required to furnish a definite capacity, the draw-down in the well is increased as the square of the velocity of the water entering into the screen.

Numerous tests have been made with special testing apparatus in the shape of a segment of formation under glass showing the various rates of flow from sands and the proper size gravels for their retention under various heads. The proper size gravel will offer no measurable resistance to the flow of water through it up to the capacity of the sands being developed.

DETAILS OF DRILLING METHODS

The jetting, or hydraulic mining system in under-reaming has its greatest advantage in that all of the sand formations are mined out to the maximum distance, especially the looser finer trouble making sands. If these spaces are filled with a graded gravel of a size most efficient for the size of the sand which is to be supported, the whole may be irregular but it will conform to the specific needs of the various strata and types of the material to be screened.

All under-reaming is done with drilling fluid, or water containing

mud in suspension, so that the back pressure of the column of muddy water will tend to seal up and hold in place the sand while the drilling is being accomplished and also to remove from the operation the sand which is cut out.

In the mechanical under-reaming this mud is forced into a plastic layer on the sand walls which is difficult to remove, while with the jet method this mud formation remains in finely divided or non-plastic form and flows through the gravel freely. In mechanically under-reamed wells it has been found that the diameter may be made so great that it is impractical to break down the plastic mud which would be left between the gravel and the native sand formation and in many instances this has been known to make a complete seal.

The time to remove this mud is at the time the gravel is placed whether the gravel is placed by washing it into the uprising stream of wash water or whether it is placed by positive means to the point where it is desired. With all methods the one essential is that the mud be removed. This is best accomplished by washing with jets of considerable volume at approximately the upper portion of the rising screen of gravel as it is placed.

The older means of developing gravel wall wells is that of the conventional system of agitating or hydraulicing and known by half a dozen descriptions more or less vague and full of mystery. These are usually called "Systems" which is meaningless to the engineer and all are the same in fundamentals.

A hole is drilled and an outer casing set to any desired or specified depth and then a hole drilled through all formations, a screen, usually too fine, set opposite the water bearing sands; gravel usually without any basis of size as related to the water sand, dumped in the space filled with drilling fluid. Then the "System" is applied. The well is bailed out, agitated with a close fitting swab run rapidly up and down the well tube, bailed again, pumped out and the operation repeated until enough gravel is introduced to give the desired results. Such desired results are obtained in many instances. They are approached in many others and are not in still others. Yet this gravel wall well of yesterday was such an improvement on the sand screen well and on Moses' idea that it has been of the utmost value to the art of ground water recovery. The thickness of the gravel wall or envelope with this process is decidedly limited because it is

impractical and nearly impossible to expect to agitate or back-wash effectively through 6 inches or more of gravel.

In some communities the pull back system has been used with more or less success. This consists of extending a casing down through water bearing formations and setting the screen concentrically in it, filling the space between the screen and casing with gravel and pulling back the outer casing. This cannot be done with the casing which has been cemented to the soils. Consequently from a standpoint of cost and dependability, this type of well has its decided limitations both in possibility of installation and in the capacity which can be expected as permanent capacity of sand free water. Except in very shallow formations it is impractical to consider withdrawing much larger than 18-inch or 20-inch casing. If an 8-inch screen is installed in this casing this leaves only 6 inches of gravel. This is perhaps sufficient for small capacity units but 6 inches of gravel with an outer diameter of only 18 inches will not successfully screen out fine sands under the high velocity required to give a high capacity.

(*Presented before the Southeastern section, April 8, 1936.*)

THE VALUE OF EFFICIENCY IN THE PURCHASE OF PUMPING EQUIPMENT

By A. M. Brenneke

(City Engineer, Denison, Texas)

So many different types of equipment are available to meet the many variations in pumping requirements that no attempt will be made in this paper to compare the efficiency of one type of equipment with another; that is, centrifugal pumps as against airlift or plunger pumps for wells, or horizontal centrifugal pumps against reciprocating pumps for work from surface reservoirs.

Briefly stated, the value of efficiency in any pumping equipment is the monetary saving which will accure to the owner throughout the life of a pump, due to the more effective use of power purchased or generated to drive the pump, whether it be electric power purchased, or coal, fuel oil, natural gas, or gasoline purchased to generate electric power, or to operate the driving mechanism.

Let us take the horizontal centrifugal pump, direct connected to an electric motor, for which current is purchased from some utility company. Depending upon its location and the size of the city, electric power can be purchased through most companies at various rates, from about 0.7 to 3 cents per kilowatt hour. We will assume that its cost is 1 cent per kilowatt hour, as this is a fair average except in very small towns.

Centrifugal pumps have been developed to the point where efficiencies now range up to as high as 90 percent in the larger sizes, and for a user to purchase a pump with an efficiency of less than 70 percent would be more costly during the life of the pump than would be a pump with an efficiency of 80 percent or better, even at an increased cost, if the pump operated as much as ten hours daily average.

Let us see. Assume a 2,000 gallon per minute pump against a head of 250 feet direct connected to an electric motor, for which current is purchased at 1 cent per kilowatt hour. This pump station is some distance from town, and the line loss is 5 percent. Motor efficiency will be assumed at 95 percent. Under these conditions, the work

done in pumping water equals $\frac{2000 \times 8.33 \times 250}{33{,}000}$, which equals 126 horse power of actual work. With a pumping unit 70 percent efficient, $\frac{126}{70}$ equals 181 h.p. transmitted to the pump. With a motor 95 percent efficient, $\frac{181}{95}$ equals 190 h.p. motor input. With a 5 percent line loss, $\frac{190}{95}$ equals 200 h.p. purchased to secure 126 h.p. of work done. 200×0.7457 equals 149 k.w. Assume this pump operates 20 hours per day. In one year it would use $149 \times 20 \times 30 \times 12$, which equals 1,072,800 k.w.h., which at 1 cent gives an annual power cost of $10,728.

Were this pump a unit 80 percent efficient, $\frac{126}{80}$ equals 158 h.p. transmitted to the pump. With the same 95 percent efficient motor, $\frac{158}{95}$ equals 166 h.p. motor input. With the same 5 percent line loss, $\frac{166}{95}$ equals 175 h.p. purchased to secure 126 h.p. of work done. 175×0.7457 equals 130.5 k.w. Operating 20 hours per day, in one year it would use $130.5 \times 20 \times 30 \times 12$, which equals 939,600 k.w.h., which at 1 cent gives an annual power cost of $9,396.

The first cost between two or more pumps under consideration is, of course, an important item, but when one spends for power during the life of a pump about twice as much per year as the pump costs, then the matter of relative operating cost is of infinitely more importance than the matter of first cost, and should be given more consideration.

Carrying our calculations a step farther, let us assume that the 70 percent efficient pumping unit costs $4,000 installed, and the 80 percent efficient pumping unit costs $5,000 installed. If this pump lasts for ten years, then its total cost over a ten-year period, under these conditions, would be as follows:

	70 percent efficient pump	*80 percent efficient pump*
Original investment cost	$4,000	$5,000
5 percent interest on investment	2,000	2,500
Power costs	107,280	93,960
75 percent depreciation	3,000	3,750
Total 10-year cost	$116,280	$105,210

The items of obsolescence and pump repairs have not been taken into consideration in the above tabulation, for the reason that they would be so indefinite in either case that they would have little if any value that would affect the final comparative results.

In view of pump developments in the last ten years, the item of obsolescence will probably work a greater disadvantage to the less efficient pump than to the more efficient pump, and in this argument for the use of the more efficient pumps, by eliminating obsolescence we err on the conservative side, if at all.

As regards pump repairs, any difference in cost as between the two pumps over a period of years would likely be controlled more by the design of the particular pumps in question than by their relative efficiencies, for if the water contains sand, a highly efficient pump can be cut out as easily and as quickly as a less efficient pump, unless the material used is more resistant to abrasion.

From the foregoing tabulations of total costs of the two pumps in question, it is seen that an additional investment of $1,000 in the purchase of a pump with 10 percent higher efficiency will save the purchaser something over $11,000 in ten years, or $1,100 a year. The return of $1,100 annually on an original investment of $1,000 would appear to be a sound investment.

This is the value of efficiency in the operation of pumping equipment.

Various formulas have been developed which will evaluate 1 percent in the efficiency of a pump in terms of original pump cost, but it is believed that a direct comparison of total cost over a period of years between any pumps in question, for a specific installation, is at least more concise in results, for in the final analysis we are not concerned so much with what a purchaser may be able to pay in the way of a premium for a more highly efficient unit, as we are with what actual costs will be throughout the life of the pump. It is believed that in receiving bids for pumping units for any specific installation, specifications should be so written that the bidder would be advised that the best bid will be determined by comparing the total cost of the unit over its estimated life, which total cost shall include the original investment, interest on the investment during the life of the pump, total power cost, and depreciation. Then, a comparison of the total cost figures over the estimated life of the various pumps being considered is a far more accurate measure of which bid is the lowest and best bid.

(*Presented before the Southwest section, October 16, 1935.*)

INFORMATION ON WATER AND SEWAGE PROBLEMS WHERE TO FIND IT

By L. H. Enslow

(Editor, "Water Works and Sewerage," New York City)

The subject is broad and will be dealt with only in part. I will content myself with stating where information of various sorts may be found.

It goes without saying that information required by water works men and sewage works operators is not concentrated in two or three books. The nearest approach to concentrated information for water works men is found in the manual published by the American Water Works Association—"Water Works Practice."

Regardless of the availability of published information, reference books, etc., it is well known that practical experience is essential in solving most water and sewage problems.

REFERENCE BOOKS

Textbooks, manuals, hand-books journals, and catalogs are named in the attached list of recommenced reference works for water and sewage works men.

The list represents the majority opinions of operating men, managers, engineers and chemists. I was somewhat reticent about taking the sole responsibility of naming such a list and therefore called on men fully qualified to offer suggestions to make up a set of reference works.

I had not thought of catalogs put out by manufacturers as being of value beyond use in specifying and purchasing materials and equipment, but one of my collaborators who is Superintendent of Operations of a company operating a large number of plants states the following:

"I find that in my own work the most frequently consulted books are the catalogs of the manufacturers of water works materials and equipment. These catalogs are in constant use, not only in connection with the purchasing of the goods listed, but also due to the

vast amount of information contained in them as to the available styles, weights, dimension, capacities, and many other features."

SMALL WORKS AND LARGE WORKS

It had been my thought that I might make up a list of reference works which would cover the needs of managers and operators of small and medium sized works and another which would be more extensive for the larger works. A superintendent of a small works writes as follows, and I am forced to agree with him to a major degree.

"In my opinion, the small town superintendent should have just as complete knowledge of fundamentals as the large town superintendent and in fact would have problems coming to his personal attention which might require more detailed knowledge than would be the case with the superintendent of a large system who would delegate such work to various assistants."

CURRENT INFORMATION

Current information is best obtained through the technical journals, trade papers, manufacturers' publications.

Attending meetings, listening to papers read and discussion of these, is of paramount value. Demonstrations such as those put on during meetings are extremely valuable and operations of this nature can not, as a rule, be found described in books. Operating papers in the journals and trade publications, however, frequently describe "operating kinks" of a great value.

REPRINTS AND BULLETINS

Manufacturers and Trade Associations frequently distribute information of value in the nature of reprinted articles, house-organs or bulletins. Ofttimes these are mailed out only upon request, or by sending in a coupon incorporated in an advertisement. It therefore pays to read the ads.

Such publications usually contain valuable information and often serve a very useful purpose. If they are not bulky these may be filed away or placed in a loose leaf binder under the heading of the subject matter, as for example, "Meters and Meter Maintenance," "Tanks and Standpipes," "Water Treatment," "Algae Control," etc., etc. If bulky, they may be torn apart and the most valuable

parts filed for future reference. It is surprising how much worthwhile information can thus be accumulated in a readily available form and at practically no cost. Some men make a practice of tearing apart technical magazines and filing the desired contents under subject matter heading where the information will be more readily available theretoafter.

FILING SCHEMES

I have found the following filing schemes practical, serviceable and inexpensive:

For the office, the old fashioned and inexpensive box letter-file, made of cardbord and wood, is very useful. The index is removed and the clippings, reprints, etc., covering a single subject-head are placed in envelops or folders properly labeled and preserved in the box files. These boxes are properly labeled to show their subject matter contents and stored on end on a shelf as one would store a set of books. As the contents of a single box grows it may be necessary later to devote an entire box to a single subject head. "Water Treatment" for example will probably require a single box which may contain a folder on water softening and others on coagulation, aeration, corrosion control, etc. One subject head can be broken down into as many sub-divisions as may appear desirable. I have one which contains 16 sub-divisions and this assists in prompt location of the desired information when needed.

Some people may prefer to use metal box files of the same size which are also available, but more expensive. Others may prefer a set of loose leaf binders, but I find the boxes are simpler, offer more protection to the filed sheets and keep the dust out.

Information such as conversion factors, data tables and formulae which are more frequently used may best be filed in a pocket-size loose leaf book. The paper can be reinforced with little gummed linen eyelets where the rings pass through and the sheet folded if need be to fit into the binder or it may be cut into parts and glued at its corners to both sides of a filler sheet of the binder. An index in the binder serves a useful purpose since it facilitates location of the desired tables of data or conversion figures. For work in the field the pocket size loose-leaf book is almost indispensable. I have one fairly well filled with curves and data cut from magazines, journals, and booklets distributed by manufacturers.

SHORT COURSES FOR SUPERINTENDENTS AND OPERATORS

This scheme has been followed successfully in many states. The courses are so arranged that those taking it are not in the least embarrassed by any lack of prior education. Much of the course is of a practical nature and the chemistry and biology lectures and laboratory work are made simple and attractive. Superintendents who have attended these schools have found them very helpful and have returned to take the courses another year, which is an excellent indication of their usefulness: Materials men, factory representatives, sales engineers and other specialists are called upon to give demonstrations of important equipment used in water works systems. All of this is very useful and helpful to the manufacturer as well as the students. Questions are freely asked and answered.

I do not hesitate to recommend the Short Course to every one of you and I believe that you will find the slight expense and the time spent a thoroughly good investment.

SPECIAL AND UNUSUAL PROBLEMS

When a special or an unusual problem presents itself to water works or sewage works operators, information required may not be easily found in published form. In such instances the State Health Department personnel can be of material help. I can assure you, as a former operator and later affiliated with two State Departments of Health, that the engineers and chemists connected with the Department are always glad to assist the operator or the management of a public works wherever they can. Call freely on your Health Department Engineer for information and advice and you will be the gainer.

In instances, the problem will be of a nature that can be solved by utilizing information obtainable through the Research and Development Departments of Manufacturers, Institutes, or Trade Associations. In my capacity of Research Engineer of the Chlorine Institute I have frequently been able to supply special information covering problems in chlorine application which, naturally, I was better prepared to give than someone else because of my long and intimate contact with chlorinating problems. Other associations are equipped to give similar service in connection with their products.

I have not understood why consulting engineers and chemists are not more regularly approached for advice and information covering

special problems. I believe that managers of water and sewage systems overlook the value of having their municipality retain consultants on an annual fee basis in order to be in a position to seek advice as frequently as need be by mail or phone. This is practiced by some cities but as a rule the small municipalities, which would profit relatively more perhaps than the larger cities by such an arrangement, fail to take advantage of this relatively low cost service. Consultants are not prone to charge small municipalities as heavily as they would those more able to pay. Industry finds that it pays to retain consultants on an annual fee basis and it seems that municipalities should find the same.

I believe that every home should have its family physician and that every municipality needs the services of a consulting engineer to prescribe "remedies" over the phone just as the family physician does and thus frequently saves the patient much discomfort or prevents the necessity of a "major operation" later.

I find an increasing tendency on the part of small towns to retain chemists and engineers to supervise plant operations and at the same time supply advice and information whenever required. If engineers and chemists were as good salesmen as are lawyers and physicians, more of this kind of valuable service would be made use of.

VISITING

An excellent means of procuring information covering operation and maintenance is by visiting water and sewage works plants. Many of us are prone to inspect the works of our neighbors with a critical eye. We see too easily the weak points. If, on the other hand, we should look around and make inquiries in a less critical frame of mind, or with an attitude of seeking all possible information, more of value could be learned.

When one attends a water or sewage works meeting or a short course he is actually "visiting" because there he meets and talks with men from other places. That is next in value to an actual visit or first hand inspection of the other fellow's works. I wish to stress the importance of visiting and exchanging experiences.

Acknowledgment. I acknowledge, with appreciation, the assistance of the several men who contributed suggestions of reference books, catalogs, etc., which proved helpful in preparing the following lists:

LIST NO. 1—FOR THE SMALLER WATER WORKS MANAGERS AND OPERATORS

Books	*Publishers*	*Authors*
Water Works Practice—Manual of the A. W. W. A.	Williams & Wilkins, Baltimore, Md.	Various
The Operation of Water Filtration Plants (F)	N. C. State Dept. Health, Raleigh, N. C.	
Water Supply Control (F)	N. Y. State Dept. Health, Albany, N. Y.	
Water Works Handbook	McGraw-Hill Co., New York City	Flynn, Weston and Bogert
Water Purification Control	Williams & Wilkins, Baltimore, Md.	Hopkins
Standard Methods of Water Analysis	A. P. H. A., New York City	
Water Purification	McGraw-Hill Co., New York City	Ellms
Manual of the American Steel & Wire Co., Water Purification (F)	American Steel & Wire Co., Chicago, Ill.	Brown
Use of Copper Sulphate in Control of Microscopic Organisms (F)	Nichols Copper Co., New York City	Hale
Technical Bulletins on Chlorination (F)	Wallace & Tiernan Co., Newark, N. J.	Various
Reprints of Articles on Chlorine and Its Application	The Chlorine Institute, New York City	Various
Hydraulic Tables	John Wiley & Sons, New York City	Williams and Hazen
Cameron Hydraulic Data (F)	Ingersoll-Rand, Phillipsburg, N. J.	
Handbook on Fire Protection	D. Van Nostrand Co., New York City	Crosby, Fiske and Forster
Fire Engine Tests and Fire Stream Tables	National Board of Fire Underwriters, N. Y. C.	
Plumber's Handbook	McGraw-Hill Co., New York City	Dibble
Handbook of Cast Iron Pipe (F)	Cast Iron Pipe Research Assn., Chicago, Ill.	
Examination of Water	John Wiley & Sons, New York City	Mason and Buswell
Public Water Supplies	John Wiley & Sons, New York City	Turneau and Russell
American Civil Engineering Handbook	John Wiley & Sons, New York City	Merriman and Wiggin

Books	*Publishers*	*Authors*
Lefax—Data Sheets for Loose Leaf Note Books	Lefax, Inc., Philadelphia, Pa.	Various
Lime—Its Use in Water and Sewage Treatment (F)	National Lime Assn., Washington, D. C.	
Water Supply & Treatment (F)	National Lime Assn., Washington, D. C.	Hoover
A. B. C. of Hydrogen Ion Control (F)	LaMotte Company, Baltimore, Md.	
Modern pH Control (F)	W. A. Taylor Co., Baltimore, Md.	
Water Supply Engineering	McGraw-Hill Co., New York City	Babbitt and Dorland
Microscopy of Drinking Water	John Wiley & Sons, New York City	Whipple
Plane Surveying	John Wiley & Sons, New York City	Tracey
Water Works & Sewerage Reference & Data Book	Gillette Publishing Company, Chicago, Ill.	

(F) Available as Free Publications.

JOURNALS AND MAGAZINES

Journal American Water Works Association
Journal New England Water Works Association
Technical Magazines—one or more.

LIST NO. 2—FOR MANAGER, CHEMISTS AND OPERATORS OF LARGE WATER WORKS

(In addition to List No. 1 for smaller works)

Books	*Publishers*	*Authors*
Fresh Water Biology	John Wiley & Sons, New York City	Ward and Whipple
Fresh Water Algae	McGraw-Hill Co., New York City	Smith
Elements of Water Bacteriology	John Wiley & Sons, New York City	Prescott and Winslow
"Industrial Water Supplies"	Ohio Geological Survey, Columbus, O.	C. W. Foulk
The Determination of H. Ions	Williams & Wilkins Co., Baltimore, Md.	Clark
pH and Its Practical Application	Williams & Wilkins Co., Baltimore, Md.	LaMotte, Kenny and Reed
Microscopy of Drinking Water	John Wiley & Sons, New York City	Whipple, Fair and Whipple
Elimination of Tastes and Odors in Water	McGraw-Hill Co., New York City	Baylis

Books	*Publishers*	*Authors*
Boiler Feedwater Purification	McGraw-Hill Co., New York City	Powell
Chemistry of Water and Sewage Treatment	Chemical Catalog Co., New York City	Buswell
Water Borne Typhoid Fever Outbreaks	Williams & Wilkins Co., Baltimore, Md.	Wolman and Gorman
Textbook of Bacteriology	Appleton & Co., New York City	Hiss and Zinsser
Water Supply Paper 274	U. S. Geological Survey, Washington, D. C.	Stabler
Corrosion: Causes and Prevention	McGraw-Hill Co., New York City	Speller
Studies of Efficiency of Water Filtration Processes	U. S. Public Health Ass'n., New York City	
Water Supply Engineering	McGraw-Hill Co., New York City	Babbitt and Doland
Handbook of Hydraulics	McGraw-Hill Co., New York City	King
Concrete Engineers' Handbook	McGraw-Hill Co., New York City	Hool and Johnson
Pocket Companion (F)	Carnegie Steel Corp., New York City	
Handbook on Pumps (F)	Worthington Pump Co., Harrison, N. J.	
Business Law for Engineers	McGraw-Hill Co., New York City	Allen
Mechanical Engineers' Handbook	John Wiley & Sons, New York City	Kent
Elements of Hydraulics	John Wiley & Sons, New York City	Merriman
Guiding Principles of Public Service Regulations (3 Vols.)	Public Utilities Reports, Inc., Rochester, N. Y.	Spurr
Theory and Practice of Public Utility Valuation	McGraw-Hill Co., New York City	Maltbie
Public Utility Rates	McGraw-Hill Co., New York City	Barker

(F) Available as Free Publications.

LIST No. 3—FOR OPERATORS AND MANAGERS OF SMALL SEWAGE WORKS

Books	*Publishers*	*Authors*
Operation and Control of Sewage Plants (F)	New York State Dept. Health	N. Y. State Dept. Health
Arithmetic of Sewage Disposal	John Wiley & Sons, New York City	Imhoff and Fair

Books	*Publishers*	*Authors*
Sewerage and Sewage Disposal (A Text Book)	McGraw-Hill Co., New York City	Metcalf and Eddy
Chemical Analysis of Water and Sewage (with explanatory sections)	Edwards Brothers, Ann Arbor, Mich.	Eldridge and Theroux
Sewerage and Sewage Treatment	John Wiley & Sons, New York City	Babbitt
Bulletins Nos. 59, 68, 69, 84 and 86 (F)	Iowa State College, Ames, Iowa	Various
Sewerage	John Wiley & Sons, New York City	Folwell
Manual of Sewage Works Operation	New Jersey Sewage Expt. Sta., New Brunswick, N. J.	
Reprints of Technical Papers on Chlorine in Sewage Treatment (F)	Wallace & Tiernan Co., Newark, N. J., and The Chlorine Inst., N. Y. C.	
Sewage Chlorination (F)	American Pub. Health Assn., New York City	Committee Reports
Sewage Disposal	John Wiley & Sons, New York City	Kinnicutt, Winslow and Pratt
Lime—Its Use in Water and Sewage Treatment (F)	National Lime Assn., Washington, D. C.	
Chemical Treatment of Sewage (F)	Amer. Pub. Health Assn., New York City	Committee Report
Water Works and Sewerage Reference & Data Book	Gillette Publishing Co., Chicago, Ill.	

JOURNALS AND MAGAZINES

Sewage Works Journal
Technical Magazines—one or more.

(F) Available as Free Publications.

LIST No. 4—FOR MANAGER, CHEMISTS, AND OPERATORS OF LARGE SEWAGE WORKS

(In addition to List No. 3 for smaller works)

Books	*Publishers*	*Authors*
American Sewage Practice Vol. 3, Sewage Treatment (1935 Edition)	McGraw-Hill Co., New York City	Metcalf and Eddy
Solving Sewage Problems	McGraw-Hill Co., New York City	Fuller and McClintock
Sewerage and Sewage Treatment	John Wiley & Sons, New York City	Babbitt
Sewage Disposal	McGraw-Hill Co., New York City	Fuller

Books	*Publishers*	*Authors*
The Chemistry of Water and Sewage Treatment	Chemical Catalog Co., New York	Buswell
The Hoover Plumbing Code (F)	U. S. Bureau of Standards	
Public Health Reports Bulletin No. 132	U. S. Public Health Service	

(F) Available as Free Publications.

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TOWARD COMPETENT GOVERNMENT[1]

By Clifford W. Ham

(Executive Director, American Municipal Association)

Andrew Jackson said that the duties of public office in the early part of the nineteenth century were "so plain and simple" that "men of intelligence can readily qualify." But Jackson himself unconsciously admitted the untruth of the statement even at that time when he complained of the difficulty of securing honest and effective tax collection with a constant turnover in tax officials. Regardless of the situation one hundred years ago, today governmental functions are technical and require special competence for their successful performance.

WHY GOVERNMENT IS COMPLEX

The technical complexity of governmental activities has developed as a by-product of other easily recognized social factors:

1. The increasing urbanization of the country as a whole. Slightly more than one-fourth of the population lived in urban places in 1880. Today three-fifths of the people live in towns and cities. City living requires performance of many functions on a community basis which the individual on the farm could do for himself or which were not necessary there. Examples are street construction, water supply, sewage disposal, food inspection, and transportation.

2. In recent decades, the movement of population has been not only to cities but to large cities and their environs. Movement of population and a high birth rate have resulted in densely populated metropolitan areas. Approximately 45 per cent of the population resided in 1930 in 96 "metropolitan centers."

[1] In somewhat condensed form there is presented a report prepared by the American Municipal Association in coöperation with the International City Managers' Association and the Civil Service Assembly. The report was prepared for the information of the President's Committee on Vocational Education. By permission of C. W. Ham, Executive Director of the American Municipal Association, the material, hitherto available only in mimeographed form, is published by this Journal.

Dense population has complicated activities which could once be considered simple. For example, the volunteer fire brigade which could be summoned by a whistle on the town hall has been replaced by a highly organized fire department.

The development of commerce and industry with their increased fire hazards, have made the task of fighting fires exceedingly technical. Well-trained fire leaders must be able to execute the customary "evolutions" but they must be proficient in such sciences as elementary chemistry and hydraulics. A high type of training is essential if fires are to be fought, controlled, and prevented. Similarly, the police officer who could direct traffic with a whistle at the four corners is replaced by a traffic squad which must assure a steady flow of continuous traffic through a metropolitan district.

3. The development of modern science has stimulated public demand for the performance of many functions which are clearly of community interest but which could not formerly be performed because of lack of knowledge. Examples are compulsory vaccination against small pox, control of tuberculosis, purification of water supply.

4. Scientific developments have also magnified the complexity of many of the oldest governmental functions. For example, criminals who use automobiles, radio, and advanced firearms can be apprehended only by the use of advanced scientific methods—two-way radio, teletype, ballistics, fingerprints, moulage, photography, etc.

5. The development of large scale corporate organization in industry has diminished the effect of the free play of competition in regulating private enterprise.

In the interest of community welfare, government is compelled to enlarge the scope of its regulatory functions. As exemplified in the field of transportation, laws and administrative rules regulate common carriers to ensure adequate protection of public health and safety, regulate the number of common carriers where public convenience and necessity is involved, and, in some cases, control rates of transportation agencies. Thus, administrators are compelled to face perplexing problems of regulation which tax the ingenuity of highly-trained lawyers, accountants, and engineers.

6. The development of mass production and of machines which supplant labor has greatly diminished the quasi-independent status of the workingman. With the passing of the frontier which once afforded him an outlet, the worker is compelled to rely on government to protect his economic status. The stupendous task of organizing

and administering programs of social security cannot be undertaken by the average lawyer, accountant, or social worker. It requires special training and social foresight.

7. Population today is mobile as never before. Mobility has been made easy and almost natural through the development first of railroads, then of automobiles and hard roads, and now of house trailers. Heretofore citizens have paid for services rendered them by governmental units in which they maintained a legal residence. Many mobile citizens now have no legal residence, but require the same services as before. Governments must find a way whereby mobile citizens will contribute their just proportion to the cost of services wherever they are rendered.

GOVERNMENT BECOMES SYSTEMATIC

Organized knowledge is a characteristic not only of general government, but also of the constituents: police, fire, library work, public recreation, public health, public works, public welfare, tax administration, water works, publicly owned utilities, public personnel activities, public finance, city planning, and many others. This is demonstrated by: (1) professional organizations of public officials engaged in the collection and dissemination of knowledge as to principles and practices; (2) monthly or quarterly journals devoted to making this knowledge available to officials on the job; (3) training courses of many types which are reaching at least a small percentage of officials in the field and which will be fully described later in this report; (4) publications of special technical committees organized to codify accepted practices.

In all fields of governmental activity a sufficient body of knowledge has been and is being accumulated which, if possessed by officials on the job, would have an immeasurable effect in improving the quality of the services which government is asked to render. The problem is to make this knowledge available to public officials generally through a permanent, organized training program.

PRE-ENTRY OR IN-SERVICE TRAINING

There are two types of training for public employees—pre-entry and in-service. The former term applies to training given in high schools, colleges, and universities before the individual becomes a governmental employee. The latter usually consists of specialized training necessary to perform specific tasks, and is exclusively for

men and women who are already governmental employees. Each type of training has a proper place in the preparation and continued effectiveness of governmental employees.

In educational institutions

More than eighty colleges and universities are now offering a general undergraduate course in public administration. Significantly, 38 of these have initiated the course in the last five years. Such courses are generally given in the junior and senior years and are based on the assumption that administration presents some common features and problems and perhaps even principles which are common to all levels and functions of government. The student is thus exposed to a carefully weighed consideration of the problems which he will inevitably meet as he progresses up the career ladder of his own specialty.

In addition, the professional schools are advisedly laying more emphasis on the social and governmental aspects of their own fields of knowledge. Engineering schools are offering more courses in city planning and public management besides the traditional courses in highway design and construction, and the Massachusetts Institute of Technology has announced a new five-year course to educate scientists and engineers for the public service, which will undoubtedly include a liberal amount of work in the social sciences. Medical schools are expanding the public health phases of their work. More and more courses in the law schools deal with the relatively new but rapidly expanding fields of administrative law, legislation, and judicial administration.

A third class of institution offers specific pre-entry training usually in a field where a definite curriculum content can be determined with general agreement, and where a definite demand can be ascertained, as in the various police and forestry courses. The School of Citizenship and Public Affairs at Syracuse University is an outstanding exception. With an indefinite demand and with some dissenters to the proposed curriculum this institution launched a one-year graduate course of training for municipal administrators in 1923 and recently extended the course to two years, offering training for the entire field of public administration. This program has been carried through with the conviction that administration has a definite content which can be taught. Many Syracuse graduates have stepped into public or quasi-public employment after graduation. Other

institutions which have followed this procedure (without, however, so definitely prescribed a curriculum) are Stanford, California, and Northwestern.

At present pre-entry training is restricted to a number of general courses in public administration and to specific training for teachers, nurses, librarians and a few other public occupations. These limitations of pre-entry training are due to: (1) insufficient experience by colleges and universities in public service training. Many universities have not yet determined whether their function is to give students special equipment for special public positions or to provide them with a general background in public administration. Many university administrators believe that the university function should be to provide the latter type of training except in public fields which are now recognized as professional. For example, a prospective public health official must complete a four-year general course prior to entering a further three-year course of specific training. This is not true of public officials such as police and fire chiefs, public works officials and the like. (2) Universities and colleges cannot be expected to establish training courses for specific types of public officials unless their graduates have a reasonable chance of being placed. There must be a general demand, for example, that a public works official be a competent, trained person, rather than a local resident or a ward committeeman, before universities can be expected to maintain public works' training. (3) Except in the professions previously noted, government is becoming so specialized that no amount of pre-entry training will prepare a prospective public employee to perform capably his responsibilities.

The case for in-service training

Universities and colleges, then, can provide only part of the training necessary for public employees. Pre-entry training must therefore be supplemented by in-service training. In addition to the limitations of pre-entry training, there are other reasons why in-service training is desirable.

1. Government involves a large number of special skills, many of which are not duplicated in private employment. Some of these skills are purely manipulative and of the type with which vocational education programs have traditionally dealt—e.g., those elements of a fireman's job which deal with tying knots, climbing ladders, running hose, ventilating buildings, artificial resuscitation. Others

are not manipulative and do not relate to activities which the employee will be expected to do tomorrow, next week, or next month. Taking the fire department again for illustration, the fire chief will run his department more effectively if he understands the relation of public fire protection activities to fire insurance rates and underwriters' requirements, if he appreciates the legal aspects of curbing arson and enforcing a building code, if he can utilize the best research methods for analyzing the fire problem in his city, and if he understands the principles of personnel administration. Most fire chiefs lack this fundamental knowledge and it cannot be taught readily in high-school or college.

2. Many public employees have had no specific training for their jobs. Continued improvement of government demands and requires that these officials be given an opportunity to increase their competence.

3. Each year a limited number of new employees enter the government service. Many of them lack specific training for their new jobs. Only through in-service training can they be given the orientation necessary to enable them to perform effectively their assigned tasks.

4. Effective government must constantly meet the changing requirements of society. The training period can therefore never be considered at an end. Public employees must always have the opportunity to keep abreast of the organized and constantly changing body of knowledge which characterizes their particular occupation.

5. In-service training is particularly valuable because it informs public employees of the possibilities of government as a career and acquaints them with the opportunities for promotion within their own and other departments. Such knowledge enhances the attractiveness of government service.

In-service training is, therefore, the key to effective execution of public policy. Federal, state, and local governments alike should regard it as an integral part of their personnel policies. Moreover, as will be shown later, federal and state governments are in a position to stimulate in-service training for local government employees.

The feasibility of in-service training may be questioned on the ground that the average tenure of the public employee is too short for effective, economical training. This impression is not borne out by the facts. In 1935, new employees numbered only 5.7 percent of all full-time employees in 596 cities over 10,000 population.

PRESENT STATUS OF IN-SERVICE TRAINING FOR PUBLIC OFFICIALS

Governmental activities in the United States are being conducted by approximately 175,000 separate political subdivisions. This total includes the national government, 48 state governments, 3,000 counties, 16,000 cities and villages, 20,000 towns and townships, and 135,000 school and other special districts. This huge governmental superstructure in 1932 employed almost 10 percent of the gainfully occupied people in the country, or a total of 3,278,500. (This figure includes 1,189,000 persons engaged in the field of education.)

In-service training programs of governmental units

The federal government. According to John E. Devine, who in 1935 prepared a study on *Post-entry Training in the Federal Service,* twenty-four federal agencies were then offering in-service training for their employees. There are six distinct types of training programs offered in these federal agencies:

1. Tuition-supported government schools
2. Concurrent training and working—optional
3. Concurrent training and working—compulsory
4. Concentrated training—Washington
5. Concentrated training—field
6. Training by correspondence

Several thousand employees enroll annually in these training programs, and in addition approximately 4,000 government employees take courses every year in universities located in Washington, D. C.

There is considerable variation in the time devoted to training and the scope of the offerings provided by federal agencies. Courses designed to orient employees in their departmental duties are given by the Farm Credit Administration. New employees on the lower levels—such as typists, file clerks and messengers—are given a four weeks' "induction" course in such matters as departmental geography, covering both the physical layout of the department, lines of promotion, and organization relationships which should be understood as a basis of intelligent participation in the work of the department. Apprenticeship training is best exemplified in the Government Printing Office and the Bureau of Engraving and Printing. Similar courses of a more concentrated nature are offered by the Federal Bureau of Investigation in the Department of Justice, where

experienced instructors devote full time to trainees during a three-months' intensive routine covering a sixty-hour week. Another type of training appears in intermittent or occasional courses, such as those given by the Bureau of Agricultural Economics and the Farm Credit Administration. In the latter, two hundred employees enroll for a fifteen-weeks' course of two lessons weekly, dealing with special matters of concern to farm credit activities. Training designed primarily for promotion, including general as well as specialized work, is a part of the curricula set up by the Bureau of Standards and the Department of Agriculture.

These so-called promotional training enterprises mentioned are the nearest approach to formal training. "In the federal government the most outstanding examples of this type are to be found in the Department of Agriculture and the Bureau of Standards. In the former a broad battery of courses is offered, while in the latter the courses are limited in number, although basic in character. In both cases the work is on a graduate level and indeed conducted in such a way that it is recognized in many colleges and universities as worthy of credit on such a level.

"The graduate school of the Department of Agriculture was organized in 1921. Like any university organization, it has its regular officers, council, and instructional staff. . . . The expenses are covered by nominal tuition charges, and the work is carried on outside of regular office hours. The department contributes space and library facilities.

"It should be noted that the courses are open to those employed in other governmental units. In fact, this is stimulated by the distribution of bulletins through the chief clerks of other departments. . . . Some forty courses were announced for the year 1935–1936. These include general courses such as those in the use of the library, the elements of personnel administration, administrative law, the editing of manuscripts, courses in German, Russian, Spanish, French, and Dutch, photography, statistical methods, and international trade, as well as such scientific subjects as plant ecology, plant genetics, colloidal chemistry, morphology of soils and the like."

It should be emphasized that while some of the federal training courses are given during regular hours, a large proportion of such training takes place after working hours.

State governments. State governments as a group have not concerned themselves extensively with in-service training. Rather than

set up training schools under their own auspices, a number of state governments have relied upon state universities. Offerings by the latter have been generally intensive, short-time courses in special fields, among which dairy and meat inspection, highway engineering and boiler operation and inspection are typical.

A notable example of coöperation between a state agency and the state university exists in California. In that state the California State Personnel Board and the University of California have worked together since 1930 in providing student personnel in the State Board with both practical and theoretical training in the specialized field of personnel administration. This particular work is given one day a week over a period of two semesters. Those sponsoring the California program hope that the success achieved in that state will encourage similar training developments in other jurisdictions not only in the United States, but also in Canada.

Of considerable significance is the fact that the state programs have been most frequently designed for special classes of employees; there has come to our attention no example of a general training program suitable for the large mass of state employees. Perhaps the most frequent and most thorough training is given state police officers.

Among states offering most extensive post-entry training are New York, California, and Maryland. In New York, where training ranges from year-round systematic courses to short intensive special work, a program serves these units: Examiners in the Personnel Division of the Department of Civil Service; state police, prison guards, physicians in state hospitals for the insane; new appointees in the Income Tax Bureau; medical and nursing staff in the State Health Department; and employees in the State Division of Placement and Unemployment Insurance. In California the educational committee of the State Employees' Association recently organized a class for the purpose of studying the general principles of public administration. The most systematized training in California is given to employees in: the California Highway Patrol; the State Compensation Insurance Fund; the State Board of Equalization, and the Unemployment Reserves Commission.

It is notable that "the California Unemployment Reserves Commission is the only department which at the present time has a Personnel Training Officer whose sole function is to carry on training work. This is a new agency of government resulting from recent social security legislation, and the training program, while compar-

atively new, is understood to include instruction both in the internal operations of the agency and in such subjects as will enable the field representatives of the agency to better represent to the public the idea of unemployment insurance."

Maryland has had training courses for penal guards, state patrolmen, dietitians, and power house operators. Since 1934 the state training program has been curtailed considerably but study is still offered to nurses and health department employees, the latter being in conjunction with the Johns Hopkins University.

Municipalities. In-service training by cities is most frequently given in police and fire departments. The intensity and frequency of training offered is restricted by available funds. It has been reported recently that in cities over 10,000 population twelve weeks of police training was given by 12; ten weeks by 6; four weeks by 6; and training of indefinite duration by 17. In most other cities within this population range organized locally supported police training is practically non-existent. Fire training by cities is quite as well standardized as police training, especially for new men. Large cities offering fire training include: Philadelphia, New York, Boston, Chicago, and Pittsburgh. Unusual police training facilities are available in Detroit, Philadelphia, Chicago, Louisville, St. Louis, Cincinnati, Newark, Wichita, and Berkeley. In the two latter cities, departmental instruction is augmented by specialists from universities and other agencies.

Among the more significant features of municipal in-service training are: first, curricula are usually offered only to two classes of municipal employees; and second, really effective training can be given only by cities with sufficient financial resources.

In-service training by professional groups

Professional organizations of public officials are taking an increased interest in in-service training. The National Recreation Association adopted the unique method in the summer of 1936 of sending a training institute on the road. A group of instructors travelling together reached, with the aid of social agencies, recreation departments, and schools, 3,800 persons in 16 large cities. By correspondence courses the Institute for Training in Municipal Administration offers a convenient training opportunity to administrative employees in cities. Functioning as a unit of the International City Managers' Association, the Institute gives a number of courses, among which

may be mentioned one in the organization and functions of municipal government and others in personnel, public works and fire administration. Other functional courses are now in preparation. A number of professional organizations coöperate with universities and state leagues of municipalities in developing training programs. Waterworks and sewage officials quite generally have been joint sponsors of conferences and schools designed especially for plant employees. In May 1936 the Joint Secretariat of the American Society of Municipal Engineers and the International Association of Public Works Officials, in coöperation with New York University, sponsored a seminar for public works officials in the New York City region. The Joint Secretariat, in coöperation with the New York State Conference of Mayors, has also sponsored short courses for similar groups.

In-service training by agencies representing local governments

During the past decade there has been a growing demand by officials and by municipal governing bodies for more competent personnel. In all probability had there been adequate training facilities available in colleges and universities to meet their needs, many governmental employees would of their own accord have attended such courses. Failing to find such facilities, public officials themselves assumed the responsibility for developing training programs which would meet their particular needs to a far greater degree than training programs previously available to them. The logical agency to which representatives of local governments turned for assistance in formulating programs of training was the State municipal league. This procedure in fact, was followed, and in-service training of municipal officials thereby became a part of the program of a substantial number of the thirty-nine state municipal leagues. By virtue of its position of leadership in the field of municipal affairs, the American Municipal Association, which is the national federation of state municipal leagues, has not only been interested in fostering in-service training but has taken an active part in furthering the movement.

Training schools in one or more of the past five years have been held under the auspices of state leagues of municipalities in Arkansas, Colorado, Georgia, Illinois, Indiana, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, Ohio, Oklahoma, South Dakota, Tennessee, Texas, Washington, West Virginia, and Wisconsin. The number of municipal officials reached by these programs was approx-

imately 7,000 in 1931 and has risen steadily until in 1936 the total attendance was approximately 14,000.

Schools have been and are being held for such varied types of municipal officials as assessors, building inspectors, city managers, city clerks, civil service commissioners, finance officers, firemen, fire chiefs, fire instructors, food inspectors, milk inspectors, park officials, policemen, police chiefs, police instructors, public welfare officials, public works officials, purchasing officials, recreation officials, sewage officials, water superintendents, and weights and measures officials.

DEFECTS AND LIMITATIONS OF IN-SERVICE TRAINING

It is no reflection on the excellent progress made by the training agencies described in the preceding section to say that without exception their programs are deficient in one or more of the following respects:

A relatively small proportion of public employees in the United States has thus far been reached by existing training programs. No effort has been made to tabulate the total number of employees trained today, but an elaborate statistical analysis is not necessary to substantiate this view. For example, in all training courses sponsored by state leagues of municipalities which have undertaken the greatest amount of public service training, the total annual enrollment is something less than 15,000. Assuming that as few as one fourth of the estimated one million municipal employees need training, the present program falls far short of that objective.

No adequate central agency for exchanging information or obtaining consultation has been established for the benefit of those concerned with in-service training. While a number of agencies deal with this particular function as an incidental phase of their work, the body of knowledge on the subject has not been correlated.

Present teaching technique is often unsatisfactory. Frequently instructors are selected because they occupy responsible positions rather then because they are thoroughly familiar with their special field and understand and practice superior teaching methods. Directors of training programs frequently fail to distinguish between lecture, conference, and other teaching methods, with the result that each of

these methods has not been successfully adapted to its particular purpose. Failure by some of the training schools to use motion pictures, film strips and other visual teaching aids, has been due not alone to limited teaching techniques but also to the absence of a central clearing house through which all such aids can be made available.

SOME ACCOMPLISHMENTS OF IN-SERVICE TRAINING

The weakness of in-service training should not be allowed to obscure the positive accomplishments to date. Although in-service training is only in its infancy, enough has been accomplished to encourage sponsors and to suggest the tremendous possibilities in further expansion of this activity.

Regarded broadly this program makes a distinct contribution to the field of adult education in the United States. Whereas much formal adult education is designed to furnish culture, general background, and a keener appreciation of things, in-service training has as a major objective the supplying of a tool with which the individual can more effectively engage in his occupation. Its direct educational value is emphasized by the fact that a large percentage of government employees commence their service with a meager general education and practically no special training for their new assignments.

An invaluable by-product of in-service training is its effect in increasing public understanding of the character of governmental work. The League of Virginia Municipalities, for example, has secured the coöperation of Rotary, Kiwanis and other civic groups in sponsoring the graduation exercises of public service training schools. Better public understanding inevitably results in improved relationships between citizens and public employees. Policemen in many states are finding that understanding of their own jobs leads to better and more courteous work; and that understanding of police work by the public makes good police service easier.

In-service training contributes also to the improvement of morale and to the development of esprit de corps. Public service occupations demanding a high degree of special skill and advanced education have, of course, their own esprits. But the greater number of public employees are not engaged in either technical work or administrative activities. Instead they are concerned with routine work which in many cases involves considerable manual or manipulative

skill. The satisfaction of knowing how best to perform these activities has a beneficial effect upon such employees. Friendly competition engendered by class work brings public employees into closer contact with one another than does the pursuit of their regular duties.

In contrast to the intangible value of improved morale, in-service training can point to tangible results in the form of monetary savings for the public. The League of Virginia Municipalities has just completed a computation which indicates that to the fire training program in Virginia is due directly some of the credit for the recent reduction in fire losses in that state. Insured fire losses in the United States as a whole and in Virginia declined at about the same rate in the years 1931–33. But in 1933 the Virginia fire training program began, and in 1935, two years after its inauguration, insured fire losses in Virginia were 16 per cent lower than losses for the country as a whole.

AN ORGANIZED TRAINING PROGRAM FOR PUBLIC EMPLOYEES

The question naturally arises whether in-service training, which has proved beneficial to a small percentage of governmental employees, is now desirable for all governmental employees who perform sufficiently specialized tasks to require training. It seems only logical that if trained policemen and firemen are doing better work in those states where they have been given courses, training facilities should also be developed in branches of the federal, state, and local governments where no training has yet been given.

This conclusion throws open such a vast field for training that it at once raises the question where to begin. It also suggests the danger of unplanned development of many types of governmental in-service training, some of which might prove effective and much of which might be partially or largely ineffective.

It may be therefore suggested at once that the agencies responsible for in-service training should first develop a sound program in a limited number of services rather than try to reach a large number of services. Advantage should be taken of the experience of those agencies which in the past several years have developed and operated in-service courses of training.

Some of this experience can be set down in the form of basic principles for the guidance of training agencies.

General principles of in-service training

1. The successful operation of an in-service training program in any governmental service depends upon a thorough understanding of the program by state or national organizations of public officials in that service.

2. All agencies responsible for in-service training should always keep posted on the activities of other agencies. This is desirable because each agency can benefit from the successes and failures of other agencies; and also because unnecessary duplication of effort can thus be avoided.

3. Training programs must be organized with regard to the territory to be covered, the number of employees to be trained, and other factors. Areas of scattered population often require a decentralized training program even though the number to be trained may be small. On the other hand, decentralization may also be necessary in a small area where a large number of officials are to be trained.

4. In-service training is a responsibility of government. Individual employees who attend training schools should not be required to do so wholly at their own expense or time.

5. Provisions must be made within any public service for training adjusted to the needs of the various types of employees to be found in the service. For example, it is not sufficient to give a fire chief the same type of training as a fireman; nor to give a detective the same sort of training as a patrolman.

FUTURE DEVELOPMENT OF IN-SERVICE TRAINING

"The type of service rendered by . . . millions of public employees will have a profound effect on the America of the future. To promote the effective performance of the duties in all levels of public employment, it seems logical that in-service training should be systematically provided." This was the consensus of opinion at the 1935 Princeton conference on training for the public service.

A commendable start has already been made in the development of systematic in-service training. No doubt the several types of agencies which are now conducting training programs will continue and expand their activities. However, collective thinking has been quickened by passage during the last session of congress of the George-Deen Act.

If the 1937 Congress appropriates funds to carry out this provision of the George-Deen Act, for the first time the opportunity will be at

hand to undertake a broad program of in-service training for public employees. According to requirements of the Act, all funds must be expended under the general supervision of the U. S. Office of Education and the specific supervision of state boards of vocational education. In turn the state boards may delegate the operation of training programs to other agencies, all of which must be legally constituted educational authorities.

In future training developments it is far more important that the coöperation of all affected agencies be obtained than that in-service training should be regarded as the function of any particular agency or agencies. It is probably best that in pioneering stages the type of agency or the combination of agencies engaged in training should be adapted to local conditions in various governmental jurisdictions.

Next steps

Further systematic development of in-service training will be greatly benefited if several guideposts are followed:

1. Training programs within particular states may be integrated. The interest and activity of state departments of vocational education will encourage a unification of state in-service training programs so that best results can be obtained.

2. Early efforts might well be restricted to a few public service occupations. While there are many classes of employees who will in all probability need training, until curricula are prepared and until more experience is gained, it would seem logical to perfect a training program in fields upon which considerable work has already been done, such as police and fire. Of course, in New York, Virginia and other states which have already had experience with other types of training, opportunity should be given to expand the program on the basis of this experience.

3. No effort should be made to standardize a training program for all states. Aside from certain general standards that might be helpful in establishing training services, there should be a maximum of freedom to make training programs fit the specific and peculiar needs of the several states.

Editor's Note: This Association, through the activity of many of its Sections as well as through its general committee on "Water Works Schools and Licensing of Water Works Employees," is mani-

festing a lively and organized interest in systematic in-service training.

It takes note that the method of promoting in-service training in one state may differ from that best adapted to the conditions in another state. But the Association, through its Directors' action, has formally recognized that the problem exists and needs study. Its members in several states are definitely promoting such training and are engaged in the administration of training courses.

The Association also recognizes that the conditions which make training and licensing important elements in efficient water works service also affect many other phases of public service. The needs are fundamentally common. Progress can be made much more rapidly if the efforts are coördinated. The American Water Works Association can be depended upon to participate in any well organized effort to promote efficiency in governmental service.

STANDARD METHODS OF WATER ANALYSIS

EIGHTH EDITION

Users of this text will please make the following corrections in all copies of the first printing:

1. On p. 1 in paragraph 3, change "Parts III and VI" to read "Parts III and IV"
2. On p. 37 in Sec. 1, 1.4, the last line should read "1 ml. is equivalent to 0.05 mg. of fluorine"
3. On p. 75 under 2.2 in last line, change "6N hydrochloric acid" to read "3N hydrochloric acid"
4. On p. 86 under 1.3 change the second sentence to read "To this add 140 g. of C. P. ammonium chloride and 350 ml. of C. P. ammonium hydroxide (sp. gr. 0.90)."
5. On p. 140, in Fig. 5, the drawing of the cross section of the sampler is in error. The edge of the lid should be shown flush with the outside of the sampler, i.e., $6\frac{1}{2}''$ in diameter.
6. On p. 177 in line 5 of Section 4, delete "200" and insert "20"
7. On p. 203 in line 7, delete "0.05" and insert "0.5"
8. On p. 204, in line 7, Sec. L., delete "95" and insert "85 to 90"
9. On p. 261, in line 2 under Section F, the word "selective" should be substituted for the word "specific"
10. On p. 264, f. 4, should read "Certified by the Biological Stain Commission (Cert. No. CBg-3 (Coleman & Bell Co.) *or equivalent*) etc.
11. On p. 286 under Option 2. first sentence should read "Into clean wet bottles add approximately *0.02* to 0.05 g" etc.

The first printing of the Eighth Edition is nearly exhausted. An earnest appeal is made that any errors not listed above be reported promptly so that all corrections may be made before the second printing.

Joint Editorial Committee,
A. P. H. A.—A. W. W. A.

Address comments to:
American Public Health Association
50 West 50th Street
New York, N. Y.

NEW PUBLICATIONS

Rich Land, Poor Land. By Stuart Chase[1]

The unusual technical background of Stuart Chase makes it possible for him to write a book such as "Rich Land, Poor Land." He has the professional background of an engineer and a certified public accountant. He has served the war time Food Administration, the Federal Trade Commission, the National Resources Board and the Resettlement Administration.

With such activities to his credit, he is able to view the land-water question as a whole rather than from the single viewpoint of the person interested in agriculture or of the engineer engaged in water supply activities.

He previews the scope of the book in these words:

"The annual rain and snow fall in America amounts to 1,500 cubic miles of water, five billion acre feet, the equivalent of ten Mississippi Rivers in their courses. Two-thirds of it falls on the right-hand half; only one-third on the left half. As rainfall begins to decline, moving west from the Mississippi, forest gives way to tall prairie grass, which in turn gives way to the short hardy grass of the Great Plains, which gives way to sagebrush, greasewood and cactus of the Great Basin. In Nebraska it takes fifteen acres to raise one beef 'critter,' in the sagebrush country 50 to 200 acres. The average man drinks a little over a ton of water in a year; a bushel of corn drinks ten to twenty tons; a pound of beef requires fifteen to thirty tons, directly and indirectly. Water is the life blood of the continent, especially of the west."

"The Appalachians being low old mountains, do not impede the moisture-bearing winds from the Atlantic and the Gulf of Mexico. Rain falls heavily on the eastern part of the Mississippi Valley. Winds from the Pacific, however, lose their moisture on the high coastal ranges and the Rockies; rainfall on the Great Basin and the Great Plains is restricted. It is most fortunate for the United States that North America has no transverse mountain range comparable to the Himalayas. Such a range would divorce the middle

[1] Published by McGraw-Hill, 1936, 361 pp. Price $2.50.

west from the mild, damp Gulf winds and cause arid or semi-arid conditions in all our north central states. Other continents—Asia, Africa, Australia—have dry centers and fabulous deserts. Not so North America—yet. But a few more generations of the course we have pursued will produce man-made deserts which will have few rivals in other continents."

He then traces the use of American land through chapters entitled: The Primeval Continent, From Plymouth Rock to Ducktown, Crop Lands, Grass Lands, Forest Lands—showing how land use has been increasingly destructive and spendthrift.

His chapter "Upstream" opens with this paragraph:

"The rain falls on crop lands, grasslands, forest and those scarified and expanding areas where nothing grows, and begins its journey to the sea. As we saw in the account of the hydrologic cycle, part of the water goes back to the atmosphere through evaporation and the transpiration of plants—if plants are there; part goes into storage on the ground or deep underneath; the rest immediately begins to run off. The runoff gathers into rills, the rills into brooks, the brooks into streams, the streams into feeder rivers, the feeder rivers into main rivers. When the runoff from a given rainfall ceases, the brooks and rivers continue to flow from the storage waters welling up in springs or held in lake, pond, marsh and swamp—unless man has emptied the natural reservoirs. The whole system of interlacing courses is commonly called a watershed, . . ."

Every water engineer has at one time or another, set up his rating scale of relative priorities for available water. Here is Chase's:

"Any watershed area is concerned with some of the uses of water itemized in the following list. A big drainage basin, like the Mississippi or the Columbia, is concerned with all of them.

1. Water for drinking and domestic purposes.
2. Water for livestock.
3. A ground water level high enough to nourish crop roots.
4. Irrigation of arid lands.
5. Supplementary irrigation of humid lands in dry seasons.
6. Water for industries, factories, steam boilers, ice making.
7. Fisheries.
8. Water for game birds and wild life.
9. Hydroelectric power.
10. Navigation.
11. Recreation, swimming, camping, scenery.

12. River sites for cities and towns.
13. Rivers as political boundaries between states and nations.

"The above are all uses of water. Here are the chief abuses:

1. Floods, artificially accelerated.
2. Low water artificially encouraged, the obverse of flood.
3. Pollution, human and industrial.
4. Erosion on the valley slopes and on river banks.
5. Silting and gravel wash.
6. Salt-water invasion at river mouth.
7. Destruction of fish, shellfish, bird and game life.
8. Destruction of natural reservoirs, ground and artesian.

"A primeval river basin knows no abuses. A healthy watershed under human control should show uses at a maximum and abuses at a minimum."

We find the public water supply industry epitomized in this paragraph:

"There are now approximately 7,100 public-water systems in the country serving eighty million people with one billion cubic feet a day. Twenty million of these people drink untreated water; thirty million drink water treated with chlorine; the balance use water treated with chlorine plus filtration. Los Angeles holds the long-distance record with water piped from Boulder Dam, 280 miles away; San Francisco's supply comes from the Hetch Hetchy Reservoir, 170 miles distant; New York taps the Catskill watershed, 150 miles to the north; Boston brings water 75 miles from Lake Wachusett. The average consumption for the country is 127 gallons per capita per day. Chicago is high with 270 gallons. Lowell, Massachusetts, is among the lowest with 50 gallons."

Finally looking to the future, Chase summarizes his ideas in these words:

"The balance of nature and modern technology in its use of fuels and metals are locked together, and together they support the American population. If technology goes out, population is cut in half; if the balance of nature goes out, population disappears. The principles of resource planning on the highest level of abstraction are two:

Hold soil, water, forest and grass at par. Over any reasonable period of time never allow net depletion. Keep inflow balanced against outflow.

"Hold the rate of mineral exploitation at a minimum, except

for abundant resources like stone and sand. Prevent needless waste. Encourage vigorous research in the field of substituting abundant minerals for rare ones.

"On these two principles, the resource base remains solid to perpetuity in respect to land and water and declines at a minimum rate in respect to minerals. Land and water we might term the *active* resources, minerals the *passive*. Trees grow, water runs, the hydrologic cycle revolves on its majestic wheel. Minerals lie dormant in their beds, and grow only in geologic time. The time elements in replacement should also be kept in mind. They run something like this:

1. *Grass.* This is the resource which can be replaced most quickly, sometimes within a year, but in the Dust Bowl not for many years.

2. *Forest.* It can be replaced in from 20 to 200 years, depending on the species of trees planted.

3. *Waters.* Artesian basins may sometimes be refilled in a few years if pumping is stopped, but most basins, lakes, rivers and ponds, when they have run low or dry, wait for their replacement on the forest cycle.

4. *Soils.* Replacement by natural means requires centuries to thousands of years.

5. *Metals.* Once mined they can never be replaced, but by remelting scrap metal their useful life can be prolonged.

6. *Fuels.* Coal, oil, gas, peat. Once used they are gone forever as men measure time. Geologic processes might conceivably replace them.

7. *Wild Life.* An extinct animal, like the passenger pigeon, can never be replaced by either geology or biology."

Occasionally the author becomes more vehement than accurate. For example at one point he states "A primeval river basin knows no abuses." Under the category of abuses he properly lists erosion and soil transportation as by products of irrational use of the land by agriculturists. But the geological evidence is plain that the lower Mississippi valley is river deposited eroded material from the upper watershed and the greater portion of this was done before ever a white man came to America. No more gargantuan erosion process can be imagined than that of the glaciers as they swept down across Canada into the United States. Man is always puny as compared to nature, even when it comes to apparent destruction. But if mankind in America is to deserve the term civilized, it will take stock

of the irrational abuses of natural resources which have gone on for the past two centuries and organize to correct them. The way he proposes to organize is disclosed in his closing chapters and should be appraised after reading the original text.

With his ultimate objective every good American can agree.

"The social mechanism is to produce the highest per capita standard of living, at the lowest man-hour cost, without stoppages or violent fluctuations and with a minimum wastage—or the highest efficiency of conversion—of natural resources."

HARRY E. JORDAN.

Epidemic Amebic Dysentery—The Chicago Outbreak of 1933[2]

This report represents the joint effort of four organizations, namely: The Board of Health of the City of Chicago; the Division of Water Purification, Department of Public Works, City of Chicago; the United States Public Health Service; and the Department of Preventive Medicine of the State University of Iowa. The report covers engineering and chemical investigations of the outbreak of amebic dysentery which had its origin in the city of Chicago in 1933. During the period of the epidemic, June 1 to December 31, 1933, there were approximately 8,500,000 visitors to Chicago and the Century of Progress Exposition. Two neighboring downtown hotels, still called "X" and "Z" in the report, were the focal centers of the epidemic. About 160,000 persons had contact with them either as guests or as casual visitors during the epidemic period. The investigation disclosed that during the period June 1, 1933 to June 30, 1934, there occurred in Chicago or in 400 cities in 43 states, but traced to Chicago as infection point, 1409 cases of amebic dysentery. The report admittedly has not listed all cases. It is impossible to gather complete data on a type of disorder where the medical profession had had so little previous contact with it.

The epidemiology of the outburst is summarized (p. 45) as follows:

"1. The epidemic had its origin in hotels X and Z.

2. There were during the period of the epidemic other unidentified sources of endemic amebic dysentery in Chicago.

3. Flies played no part in the spread of the epidemic infections.

4. Polluted ice did not significantly contribute to the occurrence of this epidemic.

[2] National Institute of Health Bulletin No. 166, United States Government Printing Office, 1936.

5. The infection was not introduced into hotels X and Z by previously contaminated fruits and vegetables.

6. Food directly contaminated by carriers among the food handlers in the two hotels was not of major importance in the production of the outbreak. It cannot be denied that the situation may have been aggravated by infections spread in this way, but the evidence seems to indicate that this had little if any part in the development of the epidemic.

7. Water was the chief effective agent in the spread of this infection. The pollution occurred within one of the two hotels through one or both of two cross-connections between sewage and water pipes, and through leakage from an overhead sewer into the cooled-drinking-water tank. A contributing factor was the heavy infestation with E. *histolytica* of hotel employees, and probably of guests who remained for longer than average periods, thus making exceptionally hazardous any pollution of water with hotel sewage."

The engineering features of the situation with recommendations are recorded (p. 90) as follows:

"This epidemic pointed out with tragic emphasis several well-known and preventable hazards to public health of an engineering nature, and also directed attention to others no less important, but not so generally appreciated. These pertain especially to such functional units within buildings as facilities for providing a safe water supply, proper sewage disposal, and general sanitation.

"The number of persons working or living within a large hotel or similar institution during a year may be equivalent to the population of a large city. Large hotels have been called 'vertical cities.' Therefore the service facilities of these buildings, especially as they relate to public health and safety, should be given the same careful supervision that a well-organized city would provide for the welfare of its citizens. Not infrequently the water supply, drainage, and sewage-disposal systems in a large hotel or institution are more complicated than similar systems for a city.

"Pressure variations in the different parts of a hotel plumbing system are more marked than is customary in a city street distribution system because of the height of the building. Hence hazards from lack of pressure or negative pressure are more liable to occur inside the building than outside. The plumbing, therefore, requires competent design, good materials and equipment, skilled workmanship, careful operation, and regular inspection by experienced and trained personnel. In view of the experiences in this epidemic the

management of large hotels or buildings would do well to follow the example of the more progressive cities in employing trained personnel to supervise such important services as water supply, sewage disposal, and general sanitation.

"The two major sanitary defects—cross-connections between the sewer and the condensers and the sewer leak around the wooden plug over the cooled-water tank—both in hotel X, serve to emphasize several important points, among them being:

1. Regulations for building cross-connections, in order to be enforced, must be backed by an adequate and experienced inspection force.

2. There is a great need for education of engineers, architects, designers, equipment manufacturers, installation artisans, and operating personnel having to do with water-supply, drainage, and sewage-disposal systems of large buildings relative to the hazards of cross-connections.

3. Proper design of water and waste piping in buildings is very important, both to prevent overloading and to avoid contamination of food, ice, and water by leakage when the pipes become corroded. Plans for each proposed new building should be carefully checked by the board of health to avoid bad design, and the building should be inspected during erection to see that the plans approved are followed in the construction work.

4. The secondary use of water in an institution may involve potential hazards of pollution and, therefore, any secondary system should be kept entirely separate from the main water-supply system.

5. The installation of new or additional plumbing fixtures in a building without providing for the extra load on the drainage system may cause serious flooding of the sewers.

6. The seasonal use of water for condensing purposes, especially in refrigeration and air-conditioning units of large buildings, may create a serious problem in the disposal of water which should be properly provided for.

7. In older buildings corrosion of iron and steel sewer pipes, especially in the upper portions and at threaded sections, may be expected. These should be tested regularly to detect points of leakage.

8. Sewers operated under pressure require special construction, especially at joints, to prevent leakage.

9. Sewers should never pass directly over water tanks or any place where water, ice, or food are prepared, handled, or stored.

10. Plumbing defects of any character should be promptly and

effectively repaired by a competent licensed plumber, and not be given temporary attention by some make-shift plan and then be neglected. Alterations and replacements should be made only by thoroughly competent men.

11. Water-storage tanks should be effectively covered. If the covers are removable, they should overlap the sides of the tank, be self-draining, and be kept locked.

12. Periods of greatest strain on the water-supply and sewage-disposal systems of buildings are to be expected with maximum occupancy and unusual weather conditions, especially when combinations of the two occur simultaneously.

Other engineering lessons derived from this epidemic are:

13. Flush valves in hotels should be provided with effective anti-siphonage devices.

14. Submerged water inlets to plumbing fixtures should not be allowed, as they constitute a potential pollutional hazard to the water supply.

15. Storage space in the basement of buildings for ice or food should be sufficiently elevated to prevent contamination in case of flooding.

16. Whenever house pumps are provided to repump water within a building, ample provision should be made to prevent a negative head on the water-supply system when pumps are operated.

17. Any unusual use for water, such as for hydraulic elevators, presses, fountains, etc., should be given special consideration in relation to possible pollution of the regular water system."

The Clinical lessons from the outburst are summarized (p. 130) as follows:

"Prior to this epidemic, it was generally held that amebic dysentery was a tropical disease. That its occurrence is not limited geographically has been effectively impressed by the outbreak. It is, therefore, a clinical entity which must be considered in differential diagnosis in all regions. Not alone may epidemic cases be encountered, but endemic infections have been found to be more widespread and numerous than generally supposed.

"That amebic dysentery may simulate a variety of common clinical conditions has also been clearly demonstrated. It is to be thought of not only in cases of "colitis," but in appendicitis, malignancy of the colon, and surgical conditions involving the rectum. To avoid errors in diagnosis, the variety of manifestations of this disease needs to be generally appreciated.

"Certain revisions in previous concepts of the clinical nature of this infection also seem to be needed. The presence of fever, for example, does not speak against an uncomplicated amebic dysentery.

"In these epidemic cases specific therapy proved to be remarkably effective. On the other hand, nonspecific medical measures were usually disappointing and surgical intervention often disastrous.

"That amebic dysentery must be commonly considered in differential diagnosis in order that it may be accurately diagnosed and specifically treated is, therefore, the major clinical lesson provided by this outbreak."

The concluding paragraph of the report is a challenge to the entire water supply industry, to those crafts engaged in the handling of sanitary equipment in buildings and to every local, state and national health administrator:

"We regard contaminated water as the most probable source of infection in the outbreak forming the subject of this report. Under similar circumstances, the problem needs to be considered from the point of view of sanitary engineering. Briefly, prevention of sewage contamination of the sources of a public water supply is required. When this cannot be assured, filtration is demanded, since usual forms of chemical treatment are ineffective against the cysts of E. histolytica. It is obvious, but too frequently overlooked, that a water supply after purification should be protected against contamination during storage and distribution and, at every point in transit, locally, to the ultimate consumer. Thorough and reasonably frequent inspections of water systems, particularly in buildings where potential hazards exist, or are likely to exist, especially in older buildings, are very much needed."

Sanitary engineers of today were taught of the dangers of mass infection by means of the Hamburg-Altona cholera epidemic or the Kennebec Valley typhoid epidemic. To the course of instruction of all future health officers and sanitary engineers must be added the lesson of the Chicago amebic dysentery epidemic.

HARRY E. JORDAN.

ABSTRACTS OF WATER WORKS LITERATURE

Key: JOURNAL of the American Water Works Association, **29**: 1, 10, January, 1937. The figure **29** refers to the volume, 1 to the number of the issue, and 10 to the page of the JOURNAL.

WATER SUPPLY IMPROVEMENT

Denver Goes to West Slope for Additional Water Supply. Eng. News-Rec., **115**: 357-8, September 12, 1935. All possible sources on east slope of Front Range of Rocky Mountains having been exhausted and further development of South Platte and its tributaries, present source of supply, being precluded by prior irrigation rights, recourse for additional supply was necessarily had across Continental Divide to new and unclaimed sources high in West Slope area. Diversion of Fraser River and its tributaries appeared most practicable and advantage was taken of pioneer bore of Moffatt railroad tunnel as ideal means of diversion. Project has passed through hectic periods of planning and financing, brief details of which are given, but construction is now under way and first water is expected to flow through tunnel next May. Plan contemplates annual diversion of 54,600 acre-feet, which will be brought to top of inclined shaft 214 feet above tunnel through system of diversion dams and collecting canals. Shaft will intercept tunnel 2700 feet east of west portal and will provide necessary head to force water over apex of tunnel, 153 feet higher than west portal. From eastern end of 6.2-mile tunnel, water will flow through concrete- and stone-paved channels to South Boulder Creek. Some 20 miles downstream, dam will divert Denver's share of creek flow southward (toward city) into 6 miles of tunnels and conduits to headwaters of Dry Creek, tributary of South Platte. At some future period, city will build reservoir and filter plant in this area and connect supply by conduit to distribution system. Meantime, a water-exchange agreement with irrigation district on Platte below Denver will enable city to augment present supply without these works. District owns water rights on Platte far enough above Denver to allow city to use water therefrom in exchange for water turned into river through Dry Creek by Moffatt diversion. Maintenance work carried out on tunnel and work contemplated are described. Present construction is being carried out under unusual PWA financial arrangement. City has deeded property and rights concerned to PWA, which, in turn, will lease property back to city for term of 30 years at annual rental of $175,000, which is sufficient to pay 4 per cent interest and amortize rent certificates issued by city to pay 70 per cent of loan-and-grant money expended. Redemption money will be derived solely from water revenues. —*R. E. Thompson.*

A Modern Water Supply for Turkey's New Capital City. F. A. LIEFRINCK. Eng. News-Rec., **115**: 225–7, 1935. Illustrated description of new water supply

of Ankara, which had population of 84,423 in 1934. Recent pipe-laying operations revealed parts of 5 different types of ancient conduits. Water is derived from the Kosunlar Valley by means of an underground barrage, from several sources in the Elma Dag (Apple Mountains) and from an impounding basin (Cubuk) originally intended for irrigation. Purification plant for the latter supply comprises aëration, alum coagulation, rapid filtration, and chlorination. Water from the other sources is chlorinated only. Distribution system is divided into 10 pressure zones, 7 of which are provided with reservoirs. All house connections are metered.—*R. E. Thompson (Courtesy Chem. Abst.).*

Third Enlargement in 83 Years Under Way in Hartford. CALEB MILLS SAVILLE. Eng. News-Rec., **115**: 351-6, September 12, 1935. History of water supply of Hartford, Connecticut, is outlined and new project described and illustrated. Consumption by the 213,000 people supplied through 27,000 services at 14.55¢ per 1000 gallons is 18.5 m.g.d. Including New Britain and East Hartford, population is 308,690 and consumption, 28 m.g.d., or 91 gallons per capita. Additions contemplated, which will enable system to supply needs of metropolitan area for 75-year period, include impounding reservoir on East Branch of Farmington River, conduits to Nepaug Reservoir, extension of filter plant, balancing reservoir near city, and additions to distribution system. Power-rights problem was settled by coöperation to advantage of both parties. Principal construction feature is Bills Brook Dam, forming Barkhamsted Reservoir. Dam is earth embankment with concrete corewall, extreme length being ¼ mile, maximum height above streambed, 137 feet, and depth to lowest foundations, 18 feet. Underground study for best location was carried out by means of test pits, wash borings, diamond drilling, and electrical resistance survey.—*R. E. Thompson.*

A New Source of Water Supply for Fort Smith, Arkansas. Eng. News-Rec., **116**: 240–4, February 13, 1936. Owing to pollution, increasing silt content, and salt water contamination, Poteau River, source of supply of Fort Smith for 40 years, has been abandoned in favor of entirely new impounded gravity supply from Clear Creek, which, rising in Ozarks, is fed by springs and drains area of 65 square miles, steeply mountainous, heavily timbered, and sparsely settled. In general, new supply consists of earth- and rock-fill dam, with new roads and concrete bridges, 8-m.g.d. rapid sand filter plant 1 mile below dam, 23-mile, 27-inch welded steel pipe line, 3 miles of 24-, 20-, and 16-inch cement-lined cast iron mains, and connections to existing distribution system. It is designed to take care of twice the existing population of 35,000, estimated period being 30 years. Dam will be 2000 feet long and 80 feet high and will impound lake 2 miles long and 650 acres in area. It will store 6000 m.g. and upper 15 feet will be sufficient for 1 year's demand. Impervious material was available for only one-half of total fill (1,000,000 cubic yards). Dam, therefore, was so designed that downstream half is constructed of semi-pervious material, such as gravel, rock, and shale. Upstream side is of impervious sand and clay, heavily riprapped. From outlet conduit, water flows through 27-inch welded steel pipe line approximately 1 mile to filter plant. Coagulation will be effected with lime and ferric chloride, latter manufactured at

plant from chlorine and iron filings. Ammonia-chlorine treatment will be employed. Mechanical equipment will provide 30-minute mixing period. Settling period, in 2 basins, will be 6 hours. From filter plant, which is at El. 800, water will be delivered by gravity through 10-m.g., 23-mile, 27-inch steel pipe line to city limits at El. 440. Line is being jointed in part with Dresser couplings and in part by welding. At creek crossings, of which there are 9, line is welded and laid in trench excavated in rock and backfilled with concrete. There are also 7 railroad crossings and one bridge crossing. Steel pipe was centrifugally lined with hot bituminous enamel. Outside of pipe was coated with same enamel and wrapped (unbonded) with 35-pound, coal-tar-saturated, pipe-line rag-felt, applied spirally and sealed at laps with hot solution. Experience with steel pipe in oil fields has led to adoption of unbonded wrap as best means of preventing damage to coating by movement of pipe in soil, since pipe slips through wrapping and is not rubbed against surrounding fill. To facilitate slipping, wrapping is coated inside with mica. To reduce water hammer, 6 automatic control valves were installed at intervals in line, designed to reduce surges to minimum and also to close automatically in case of break. Line is also equipped with 2-inch combination air and vacuum valves at all important summits and with 8-inch blow-off valves at important depressions. Except for Arkansas River bridge crossing, entire line is buried in ground, minimum cover being 2.5 feet. Brief details of contract prices included.—*R. E. Thompson.*

Progress on Large Projects. Eng. News-Rec., **116**: 207–15, February 6, 1936. **Colorado River Aqueduct.** Construction has been actively under way all year along 300-mile length of aqueduct. At end of year, only about 9 of the 92 miles of tunnels remained to be driven, most of undriven mileage being in San Jacinto tunnel, which, because of water inflow, is most difficult feature of entire undertaking. Lining is about one-third completed. In canal, conduit, and siphon sections excavation is more than one-half and concreting about one-third completed. **Parker Dam.** Work on Parker Dam, the diversion dam on Colorado River which Bureau of Reclamation is building for Metropolitan Water District of Southern California, was suspended for over 6 months pending authorization of project by Congress. Following authorization, work was resumed on twin diversion tunnels, 32 feet in diameter, around dam site on Arizona side. **Mono Basin Project.** The 11.3-mile Mono Craters Tunnel (9 feet wide), to supplement water supply feeding Owens Valley Aqueduct that serves Los Angeles, is now advancing from 4 headings, i.e., 2 portals and 2 headings from access shaft. One-third of length has been driven. Second shaft, to be 900 feet deep, is under construction. During 3.5-year period allotted to tunnel-driving, Grant Lake Dam and Long Valley Dam, earthfill and rockfill structures, respectively, are to be built. Project will cost about $7,600,000, exclusive of water rights and lands. **Raising O'Shaughnessy Dam.** Dam, which is part of San Francisco's Hetch Hetchy water system, is being raised 85 feet, making total height 430 feet and increasing storage from 206,000 to 360,000 acre-feet. Placing of concrete will be commenced early in 1936. **Transmountain Water for Denver.** Work on Moffat tunnel project was prosecuted vigorously

during 1935 following approval of PWA funds. Enlargement of tunnel from inlet shaft to apex was completed in October. Intake shaft and structures for west and east portals are ready for water. Concreting of tunnel is scheduled for completion in May. South Boulder diversion dam, canalization of creek, siphons, tunnels, flumes, and canals, it is expected, will be completed early in spring. Contract on west side for collection ditches on Fraser and Jim Creeks with diversion dams and siphons has been essentially completed. **Fort Smith Water Works.** Entirely new water supply for Fort Smith, Arkansas, costing $1,500,000, is about 75 percent completed and will be placed in operation in spring. Works include 1,000,000-cubic yard earth and rock dam, 8-m.g.d. filter plant, and 23-mile, 27-inch welded steel pipe line. About 50 percent of latter has been laid and dam is 75 percent completed. Filter equipment has not yet been installed. **Milwaukee Water Purification Plant.** A 750,000-gallon concrete wash water tank, first major structure of Milwaukee's purification plant, has been completed and tested, and 60-inch steel mains from tank and from lake to filter plant have been laid. On 24-acre site, enclosed in steel sheet-piles and extending 750 feet into lake, 2 coagulation basins, 297 x 372 feet in plan, and 2 of 3 filtered-water basins were built last year. Filters and underlying clear wells have been one-third completed. Contracts have been awarded for pumps and bids called for filter equipment. **Springfield (Illinois) Filters.** Purification plant, last unit of $5,640,000 program of water works extensions, is about half complete. Involved is 21.4-billion gallon lake costing $2,600,000, 2 dams, 2 bridges, and $1,125,000 pumping station and power plant. **Chicago Water Works.** The 12-mile, $13,000,000, Chicago Ave. water tunnel and Dever crib were completed and placed in service on December 20. New $2,250,000 Cermak pumping station is practically complete, as are tunnel connections. Novel chlorination plant at Dunne and 68th Street twin cribs is complete except for minor adjustments. **Rehabilitating Cincinnati Filter Plant.** Model of its kind when completed 30 years ago, Cincinnati purification plant is about to be rehabilitated at cost of $3,120,000. Contracts were let late in year for most of work. **New York Water Tunnel.** The 20-mile Tunnel No. 2 of New York system, extending from Hillview Reservoir in Bronx under East River to Queens and Brooklyn, was given final inspection early in January preparatory to being placed in service. **Quabbin Reservoir.** Several elements of Quabbin Reservoir project for Boston metropolitan water supply were under active construction last year. The 24.5-mile aqueduct tunnel leading from proposed reservoir to old Wachusetts reservoir and distribution system is now complete. Hydraulic-fill Quabbin dike, one of 2 large earth dams on reservoir project, was about 25 percent complete at end of year. At Swift River, site of main dam, 37 pneumatic caissons were sunk across valley floor to serve as cutoff wall for dam, contract for which is expected to be let this year. **Boulder Dam.** Diversion tunnel was closed early in year and dam was factor in flood storage and flow regulation during summer. Structure was dedicated by President Roosevelt on September 30 and since then has been entirely completed. Traffic over highway across crest has begun. Work yet to be finished is completion of penstock and power-house units and installation of certain valves and control apparatus. —*R. E. Thompson.*

Florida Canal. Eng. News-Rec., 116: 26, January 2, 1936. According to report submitted to War Department by special board of geologists and engineers now making exhaustive study of problem, ground water changes in Florida due to proposed sea-level ship canal across state will be only local and without deleterious effects upon municipal water supplies. Report is not final, as further studies are to be made on several phases of question. —*R. E. Thompson.*

Limited Effect on Water Supplies Expected from Florida Canal. Eng. News-Rec., 116: 59–61, January 9, 1936. Abstract is given of report of board appointed to study possible effect of proposed Atlantic-Gulf ship canal upon water supplies of Florida. Board was appointed as result of protests by cities in southern part of state, who feared that water supplies would be detrimentally affected. Practically all cities of state are dependent upon underground supplies believed to originate chiefly in higher lands in northern Florida, through which canal is to be cut. Board believes that canal will have no extensive injurious effect, but reserves judgment on several local water supply questions until completion of further study of underground conditions, now under way. Board does not expect its major conclusions to be altered by additional exploratory work.—*R. E. Thompson.*

Water Resources Problems Studied by State Planning Boards. Eng. News-Rec., 116: 165, January 30, 1936. Studies of water resources and utilization prosecuted by state planning boards throughout country have recently been summarized by National Resources Committee under title, "Water Resources Problems." Brief notes, largely general in character, are given from this document. It has been found that critical problems are chiefly in towns of less than 1,000 inhabitants.—*R. E. Thompson.*

Water Resources Studies. THORNDIKE SAVILLE. Eng. News-Rec., 116: 220–2, February 6, 1936. Developments toward sound policies in regard to water resources have been advanced materially during recent past as result of efforts of National Water Resources Committee and predecessor organizations. Activities preceding present wide-spread interest is briefly surveyed, from the eighties of last century, when Major J. W. POWELL gave first strong impetus to stream study, to present time. Major reports issued during 1935 are reviewed and current activities of Water Resources Committee are outlined. Author concludes that it may fairly be said that true conservation of nation's water resources is at last in sight.—*R. E. Thompson.*

MANAGEMENT

Improved Management Aids Water Works Development. P. C. GALE. Eng. News-Rec., 115: 365–7, September 12, 1935. In 1931, water department of Michigan City, Indiana, was deeply in debt; accounts receivable were extremely large; and system was about to be sold to private utility. Several prominent and public-spirited citizens secured temporary injunction and pursuaded State Assembly to enact statute providing for department of water works under board of trustees with independent responsibility for

management (later extended to be applicable to all Indiana cities). Water works revenue cannot be used for general purposes, nor can superintendent, appointed by trustees, be dismissed except by extending opportunity for public hearing. Causes for dismissal are specifically limited and include conviction of criminal offense, neglect of duty, undue political activity, disobedience of any reasonable order of board, and absence without leave. Trustees, who assumed office on July 15, 1931, immediately inaugurated, and have since maintained, extensive program of rehabilitation and improvement including new system of records, re-routing and redistribution of meter readings, revised purchasing procedure, etc. Delinquent bills have been reduced from $39,000 to slightly over $8,000, inherited bonded indebtedness of $150,000 has been liquidated at rate of $22,000 per year plus interest, surplus has been built up, cost per thousand gallons reduced, and net income per thousand gallons increased. With aid of PWA, start was made in October 1934, on construction of filter plant consisting of four 2-m.g.d. filters, reaction basins equipped with mechanical flocculators providing retention periods of 3 hours, and 1.5-million-gallon filtered water reservoir. In addition, 750,000-gallon elevated steel tank has been erected and some old wood-stave mains replaced with cast iron pipe.—*R. E. Thompson.*

Ten Years of Municipal Operation of Pomona's (Calif.) Water Works. F. C. FROEHDE. The American City, 51: 8, 62, August, 1936. Privately-owned water company showing deficit of $10,000 a year having been bought out, Pomona can now, after ten years of municipal operation, report an increasingly strong financial position with 80 percent increase in plant value, and considerable increases in water consumption, length of pipe lines, and holdings of real estate; while fire insurance and water rates have been reduced.—*Arthur P. Miller.*

Omaha Water Sales for 1934 Reported. Eng. News-Rec., 115: 537, October 17, 1935. In 1934, water consumption in Metropolitan Utilities District of Omaha, Nebraska, averaged 29.4 m.g.d., as compared with 26.2 in 1933 and 29.0 in 1930, the previous high. On basis of population of 218,000, per capita consumption was 135 gallons per day, 84 per cent being dispensed through 49,193 meters of the 52,285 services in district. Average cost per 1,000 gallons sold, exclusive of sinking fund and all other reserves, was 8.71 cents, made up as follows: pumping, 3.31; distribution, 1.1; general expenses 1.74; bond interest 2.56. Sinking funds and other reserves brought cost up to 14.29 cents. Operating income was 14.4 cents per 1,000 gallons, and income from all sources 15.88. For average residence, annual cost was $10.75, about half that prior to acquisition of plant from water company in 1912. Exclusive of depreciation, estimated at $2,900,000, present book value of plant is $12,600,000, against which there are liabilities of $5,000,000, mostly in 4½ percent bonds due in 6 years' time.—*R. E. Thompson.*

ACCOUNTING

This Water Department Prints Its Own Forms. C. E. HOGEBOOM. The American City, 51: 8, 49, August, 1936. In Wheaton, Ill., system of meter

reading and billing, forms are printed on post cards by same machine which applies the addresses.—*Arthur P. Miller.*

Stub Plan Simplifies Water-Consumer Accounting. M. F. HOFFMAN. Eng. News-Rec., 115: 368–9, September 12, 1935. Advantages of stub plan are discussed and application of system in Cincinnati outlined. Some 33,000 accounts are rendered each month, at intervals of 10 days. Of 11,000 accounts mailed each period, approximately 2000 remain unpaid at due date 10 days later, 300 at end of 10 days of grace allowed after sending delinquent notices, 75 to 100 after first call of shut-off men (at which time additional charge of $1 is made), and 5 or 6 after second call of service men 2 or 3 days later, when service is discontinued unless bill is paid. In most instances, inability to collect is due to consumers moving from premises. In 1930, with ledger plan and monthly billing, cost of meter reading, billing, collecting and accounting for 88,000 accounts was $255,000. With stub plan, 94,000 accounts were handled in 1934, monthly billings being made on 2000 large accounts, monthly readings taken on additional 20,000 meters, and bills rendered quarterly on 92,000 accounts, at cost of $125,000. There was also a decrease in number of delinquents.—*R. E. Thompson.*

AQUEDUCTS, TUNNELS AND SUPPLY MAINS

Owens Valley Aqueduct Extension Includes 11.3-Mile Tunnel. Eng. News-Rec., 115: 47–9, July 11, 1935. Work is under way on Mono Craters tunnel, 350 miles north of Los Angeles, which will divert water from Mono Basin in Owens River Basin to supplement supply now conveyed to Los Angeles through Owens Valley Aqueduct, which has sufficient capacity to take care of regulated flow from new source. Water brought in through new tunnel will afford power possibilities through head of 2,000 feet developed in Owens River gorge and again in 2,348-foot head near city. Supplemental to tunnel, 2 dams are important items of project, one an earthfill at Grant Lake for storage and regulation above tunnel, the other, a rockfill at Long Valley, 16 miles below tunnel, for storage and regulation of both Owens River and Mono Basin water. Project will also include small diversion dams, collection works, and pipe lines. Tunnel will be of 9-foot horse-shoe cross-section, inside concrete lining. Formation to be traversed is wholly igneous, including compressed pumice, various granitic formations, and tufaceous lavas, with some sand and gravel. Grant Lake Dam will be about 90 feet high and Long Valley Dam, 145 feet high and 520 feet long on crest. Project, exclusive of land and water rights, is estimated to cost $8,800,000 and construction is to extend over 3.5-year period.—*R. E. Thompson.*

Chicago Water Tunnel Blast Kills Two Workmen. Eng. News-Rec., 115: 313, August 29, 1935. Ignition of gas at base of new Wm. E. Dever crib in Chicago Ave. tunnel on August 26 by workman using acetylene torch caused explosion killing 2 workmen and badly burning 6 others. Tunnel work had been completed and construction equipment was being removed. Methane, in small amounts, was encountered during construction. Tunnel is being

allowed to fill with seepage through weep holes in lining and it is presumed that gas entered with water. Only nominal damage was done to crib structure.—*R. E. Thompson.*

Steel-Cylinder Concrete Pipe Cast in Long Sections. Eng. News-Rec., **115**: 405, September 19, 1935. Construction of Green River gravity water supply line in Tacoma, Washington, required installation of 34,000 feet of 54-inch lock-joint steel-cylinder concrete pipe, precast in 16-foot lengths weighing 9.25 tons, designed for head as high as 240 feet. After being steam-cured overnight, sections were removed from forms, steam-cured for additional 24 hours, kept wet for 7 days, and not disturbed for 14 days thereafter.—*R. E. Thompson.*

Clear Water Creek Water Project, Fort Smith, Arkansas. Eng. News-Rec., 115: 523, October 10th, 1935. New $1,500,000 project started June 1935, consists of earth and rockfill dam on Clear Creek, 6-m.g.d. filter plant, 22 miles of 27-inch welded steel pipe line, and 3 miles of 12- to 24-inch cast iron pipe line. Unit prices given.—*R. E. Thompson.*

High-Speed Tunnel Driving in Soft Material at Pasadena. Eng. News-Rec., 115: 513–4, October 10, 1935. Pasadena tunnel is part of 150-mile distribution system being built by Metropolitan Water District of Southern California to deliver to member cities water brought through Colorado River aqueduct. Tunnel, which is entirely within city, is 12,000 feet long and 10 feet in diameter inside reinforced concrete lining, which is designed to withstand maximum hydraulic head of 100 feet. Minimum lining thickness is 10½ inches in walls and arch and 9 inches in invert. Cover ranges from 30 to 80 feet. Work was commenced February 21 and, by middle of August, 73 per cent of total length had been driven. Tunnel crosses alluvial fan, or ancient delta cone, deposited in series of irregular layers by long succession of flash floods. Layers, in general, consist of damp, partly cemented and well compacted alluvium, mainly sand and gravel, with some clay lenses and a few boulders up to from 10 to 15 inches in diameter.—*R. E. Thompson.*

CONCRETE

Old-Time Continuous Mixer Used for Concrete Tunnel Lining. FRANK RASMUSSEN. Eng. News-Rec., **115**: 49–51, July 11, 1935. Old-type continuous paddle concrete mixer combined with ultra-modern belt-conveyor distribution system was selected for use in Chicago Ave. water tunnel, because of limited clearance in 16-foot bore, where muck cars had to be operated through concreting equipment. Crusher-run limestone aggregate crushed from tunnel muck is being used in ratio of 1 of cement to 3 of aggregate. Water is admitted to mixer through perforated pipe without measuring. Concrete strength of 2,000 pounds in 28 days is desired and daily test cylinders are breaking at from 2,000 to 6,700 pounds; drill cores taken at intervals of 300 feet show corresponding strengths. Driving has been in progress some 8 years by day-labor forces and tunnel was holed through in February. Main tunnel,

of straight-side circular-arch section, 16 feet in diameter, extends 193 feet below mean lake level from new crib east of Carter H. Harrison crib southwest to Two-Mile crib and thence westward, reaching mainland at Chicago Ave., 2.7 miles from crib, and continuing westward under Chicago Ave. for 5.1 miles. A 10-foot branch, 1.4 miles long, leads northward to Springfield Ave. pumping station, and 13-foot branch, 1.8 miles long, connects with Central Park Ave. station to south. Lining operations are described and illustrated.—*R. E. Thompson.*

Moisture in Concrete Sand Measured by Electric Current. CHAS. E. WUERPEL. Eng. News-Rec., 115: 52–4, 1935. Estimation of moisture content of sand by measurement of variations in electric conductance is shown to be sufficiently accurate for use in concrete work. Any inaccuracies are compensated for by the rapidity of the method, variations in moisture being instantly detected. Parallel tests with the drying method on 200 samples indicate that the conductance method is generally accurate to within 0.3 percent, with occasional variations of not more than 0.7 percent. Laboratory studies were made to determine:—(1) differences in conductance of water from various sources; (2) effect of temperature upon conductance of waters and of moist sands; and (3) effect of gradation upon the conductance of sands. The apparatus used, which was located in the sand weigh-hopper, is described. —*R. E. Thompson (Courtesy Chem. Abst.).*

DAMS

Steel Used Extensively in Building El Vado Dam. CHARLES P. SEGER. Eng. News-Rec., 115: 211–5, August 15, 1935. El Vado Dam, recently completed by Middle Rio Grande Conservancy District, is gravel fill, 1300 feet long and 175 feet high above streambed, faced with steel plates. Steel was also used for wave parapet on top of dam, for lining spillway channel, and as important element in lining part of combined river diversion and outlet-works tunnel.—*R. E. Thompson.*

Fort Peck Project and Dam. THOMAS B. LARKIN. Eng. News-Rec., 115: 279–82, August 29, 1935. **Fort Peck Project Structures.** Ibid., 283–4. **Fort Peck Land Buying Based on Aërial Maps.** Ibid., 284. **Exploring Foundations and Pits.** T. A. MIDDLEBROOKS. Ibid., 285–90. **Stripping the Base of the Dam.** Ibid., 290. **Steel Sheetpile Cutoff Wall.** Ibid., 291–2. **Placing the Hydraulic Fill.** Ibid., 292–6. **Diversion-Tunnel Driving. Enlargement from Center Headings.** Ibid., 296–300. **Excavation Methods and Equipment.** Ibid., 301–3. **Concrete Structures for Spillway.** Ibid., 303–4. **Aggregate and Toe Material Plants.** Ibid., 305–6. Details of construction progress and procedure at Fort Peck Dam.—*R. E. Thompson.*

Unmapped Eroded Limestone Complicates Corewall Job. FARLEY GANNETT. Eng. News-Rec., 115: 328–30, September 5, 1935. Illustrated description of unexpected conditions encountered in construction of low earth dike, about 2700 feet long with maximum height about 20 feet and containing 65,986 cubic

yards rolled-clay embankment, for Ontelaunee Dam of Reading, Pennsylvania, water works project. Dike extends eastward from concrete spillway section, and dike and dam are underlain with limestone. Usual borings failed to indicate unexpectedly irregular profile found after excavation. Original estimate indicated about 450 cubic yards of rock to be removed: 4,719 cubic yards were actually taken out. It was anticipated that grout holes 20 feet deep and 20 feet apart would suffice; but shortly after getting under way, holes 5 feet apart was standard practice. Ten holes took over 1300 bags of cement each and 1 required 4,535 bags. Original estimate called for 4200 bags of cement for grouting: 61,368 bags were used. Cost was estimated at $82,992, but was actually $209,018. It is suggested that, in limestone areas, exploration work should be much more extensive than in other rock and that grout requirements should be determined by test in different sections prior to making estimate.—*R. E. Thompson.*

Computing the Spillway Flow at Boulder Dam. E. MEYER-PETER and HENRI FAVRE. Eng. News-Rec., 115: 409, September 19, 1935. Reply to article, "Additional data on model tests for Boulder Dam Spillways," by D. C. MCCONAUGHY in Eng. News Rec. April 4, 1935, and brief comment by MCCONAUGHY.—*R. E. Thompson.*

Progress at Grand Coulee. Eng. News-Rec., 115: 139–40, August 1, 1935. Eight articles follow describing project, conditions which led to radical change of plans, contractor's procedure, etc. Object is to equalize flow of Columbia River, develop its power, and reclaim by irrigation 1,200,000 acres of land in eastern central Washington. Fully planned development was estimated to cost about $375,000,000. At present, only base section of ultimate high dam is being built, without power installation, at cost of $63,000,000, function being only to assist regulation of river flow. Original scheme involved low dam that would raise water level 150 feet: revised plan calls for construction, at same cost, of base section of dam 540 feet high to raise level 350 feet. **Grand Coulee Project and Dam.** KENNETH B. KEENER. 141–3. **Ten Months' Construction Progress.** 144–7. **Constructing the First Cofferdam.** 148–51. **Planning for Excavation Disposal.** FRANCIS DONALDSON. 152–3. **The Belt Conveyors in Operation.** 153–5. **Designing the Belt System.** STANLEY M. MERCIER. 156–7. **Making Aggregate at Grand Coulee.** 158–60.—*R. E. Thompson.*

Large Model Aids Study of Bonneville Project. HENRY W. YOUNG. Eng. News-Rec., 115: 195–6, August 8, 1935. One of largest and most complete hydraulic models of riverbed ever attempted has been built on bank of Willamette River near Linnton, Oregon, for exhaustive research into various phases of Bonneville project. Model, with reservoir and headworks, is 325 feet long and represents on 11100 scale 5-mile stretch of Columbia River. Model and studies contemplated outlined briefly.—*R. E. Thompson.*

Cofferdams in Swift Water for Bonneville Dam. C. I. GRIMM. Eng. News-Rec., 115: 315–8, September 5, 1935. Cofferdamming is major design and

construction problem in building Bonneville Dam on Columbia River. Channel, 1000 feet wide, has been progressively laid dry for building concrete spillway dam 1250 feet long and 170 feet high. Work has to be carried out in water from 30 to 50 feet deep, in current up to 7 miles per hour, and in rough irregular riverbed. Details given.—*R. E. Thompson.*

Unique Devices Developed to Aid Dam Foundation Grouting. Eng. News-Rec., **115**: 191, August 8, 1935. Brief description of 2 devices invented by Tennessee Valley Authority engineers to facilitate exploration of foundations and washing of subsurface seams preliminary to grouting operations at Norris Dam. With one, the "feeler," seams or faults can be located through drill holes and with the other, the "flusher," clay can be washed from seams so located.—*R. E. Thompson.*

Ice Pressure on Russian Dam Relieved by Compressed Air. Eng. News-Rec., **116**: 14, January 2, 1936. Multiple-arch dam, about 3,300 feet long, located near Magnitogorsk in Ural Mountains in U. S. S. R., may be subjected to thrust of sheet of ice about 5 feet 6 inches thick, producing pressure on face of dam of 4,600 pounds per square foot. To relieve this critical stress it was customary to cut ice abutting crest by manual labor, an operation which sometimes required hundreds of men. In winter of 1933–34, according to N. L. JUNGKIND, in Izvestiya Nauchno-Issledovatelskovo, Instituta Hydrotechniki, Vol. 15, 1935, compressed air system similar to that used on some dams in this country was installed to prevent formation of ice at crest of dam. Installation consists of 1½-inch perforated pipe line laid at depth of about 10 feet near upstream face of dam along its entire length. Perforations, 1 mm. in diameter, are spaced about 10 feet apart. Air is supplied at rate of about 13,000 cubic feet per minute by 60-hp. compressor plants at each end of pipe line. Operation for from 4 to 8 hours in 24 maintains strip of open water along crest even at temperatures of −22°F. Ice, 2–4 inches thick, which may form between operating periods can be entirely removed by applying air for about one-half hour. Effect is ascribed mainly to induced circulation, which brings to surface comparatively warm water (34–39°F.) from lower levels of reservoir.—*R. E. Thompson.*

Progress at San Gabriel Dam No. 1 on Modified Design. PAUL BAUMANN, JR. Eng. News-Rec., **116**: 114–5, January 23, 1936. Since modified plans were approved in August, 1935, for San Gabriel Dam No. 1 of Los Angeles Country Flood Control District, work has been under way on entirely new construction program. Principal changes consist of (1) flattening of both slopes from about 1.5:1 to 3:1; (2) placing of jetted rock fill in 4 of 6 zones; and (3) placing compacted fill in other 2 zones. Height remains same, about 375 feet. In new design, cross-section is divided into 6 zones; 1, 4, 5, and 6 are to consist of dumped rock which is to be hosed with high-pressure jet, volume of water used to be about twice volume of rock. Zone 2 is to be compacted impervious blanket of fine material and zone 3, compacted quarry material that has passed or would pass 6 x 9-inch grizzly. Rockfill already placed was required to be removed except that below 1:1 slope with toe 175

feet downstream from center line of dam. Material so excavated was deposited in zone 6. Nature of rock in canyon makes it desirable to do as little blasting as possible, particularly along cutoff. Special study was given to means of thoroughly grouting rock along cutoff wall. Grout holes will vary in depth from 50 to 150 feet.—*R. E. Thompson.*

Modified Soil Control Proposed for Rolled-Fill Dam Construction. FRANK B. CAMPBELL. Eng. News-Rec., 116: 158–9, January 30, 1936. Notable advances in construction of rolled-fill dams have been made in recent years as result of use of sheepsfoot, or tamping, roller and employment of control scheme, including percolation, settlement, compaction, and plasticity needle tests, developed by R. R. PROCTOR (Eng. News-Rec. August 31, September 7, 21, and 28, 1933). These methods were used in construction of embankments forming Sutherland Reservoir of Platte Valley Public Power and Irrigation District near North Platte, Nebraska, and in adapting them to that undertaking certain changes in detail, herein discussed, were made, which are believed to be an improvement.—*R. E. Thompson.*

Concrete Dam, Twice Raised, Shows Negligible Leakage. Eng. News-Rec., 116: 151–2, January 30, 1936. Lake Spaulding Dam (Pacific Gas and Electric Co.) is constant-angle concrete arch whose original height was 225 feet and crest width 20.7 feet. Face of downstream slope was left with stepped surface to facilitate later additions to height and thickness. In 1916, height was increased to 260 feet and in 1919 to 275 feet. Construction of dam was described in Engineering Record, August 9, 1913, p. 150, and in Engineering News, December 11, 1913, p. 1163. Second increase in height was described in Eng. News-Rec. November 25, 1920, p. 1020. Brief details given of additions, together with data on observed leakage. Total of perhaps 6 to 8 miner's inches of leakage comes through construction joints and that emerging from inspection tunnel is about 15 miner's inches, or $\frac{3}{4}$ second-foot.—*R. E. Thompson.*

Tunnel Progress at Parker Dam Aided by Large Drill Jumbo. Eng. News-Rec., 116: 249–50, February 13, 1936. Brief illustrated description of jumbo, with working platforms at 3 levels and mountings for 19 drills, which has facilitated progress on twin diversion tunnels, 32 feet in diameter, now being driven around Parker Dam site on Colorado River.—*R. E. Thompson.*

Lake Mead Official Name of Boulder Dam Lake. Eng. News-Rec., 116: 260, February 13, 1936. Lake formed by construction of Boulder Dam on Colorado River was, on February 6, officially named Lake Mead by Board of Geographic Names, honoring late Dr. ELWOOD MEAD who supervised construction of Boulder Dam. At full capacity, 30,500,000 acre-feet, Lake Mead will reach 115 miles up Colorado River and will have maximum width of 40 miles and surface area of about 229 square miles.—*R. E. Thompson.*

Fishways at Bonneville Dam to Cost $3,550,000. Eng. News-Rec., 116: 235–7, February 13, 1936. Elaborate system of traps, locks, ladders, and

canals is being provided to enable salmon to pass Bonneville Dam on Columbia River en route to spawning grounds above, which are considered one of major sources of salmon supply on North American continent. Value of annual salmon catch on Columbia is estimated at $10,000,000.—*R. E. Thompson.*

PUMPS

Evaluating Pump Efficiency as a Basis for Better Purchase Specifications. H. J. SUMMERS. Eng. News-Rec., 115: 375–6, September 12, 1935. Specification of financial worth of increased efficiency would give pump manufacturers incentive to produce more efficient equipment. Value of increased efficiency can be determined by evaluating each point of increased over-all efficiency above nominal standard, or by evaluating each kilowatt input of power saved for fixed output. Each of these methods is analysed, analyses applying equally well in case of pumps driven by energy other than electrical.—*R. E. Thompson.*

Special Problems Involved in Pump Replacement at Ottawa, Ont. Eng. Contract Record, 49: 533–6, June 26, 1935. Details given of new 17-m.g.d. centrifugal pump, driven by 760-h.p. hydraulic turbine, installed at Ottawa, Ontario, to replace waterwheel-driven plunger type unit.—*R. E. Thompson.*

Watertight Pump Chambers for a Flooding Tunnel. Eng. News-Rec., 115: 252–5, August 22, 1935. Limiting factor in completion of 241-mile aqueduct of Metropolitan Water District of Southern California is 8-mile section of 13-mile San Jacinto tunnel between Cabazon and Potrero shafts which has been delayed of heavy inflows of water. District has taken over work and installed horizontal centrifugal pumps at tunnel level in both shafts. Pump chamber in Potrero shaft required great care in design because it was decided to so construct it that it could operate at all times with no manual control closer than ground surface, even if tunnel should be flooded and 800-foot shaft entirely filled with water. This entailed equipment for circulating within chamber air for cooling motors, water-circulation system for cooling air, pumping system for removing seepage, and automatic control mechanisms. Seven pumps were installed, 5 of 2600-gallons per minute capacity and 2 of 1000-gallons per minute, under head of 850 feet. Lesser depth at Cabazon shaft made it more economical to provide separate shaft through which access to pump chamber would be possible at all times, greatly simplifying design. Pump installation at latter shaft consists of 4 units of 2500-gallons per minute capacity and 2 of 1000-gallons per minute at 275-foot head.—*R. E. Thompson.*

Determination of the Capacity of Water-Pumping Stations by the Chemical Method. G. HARMSEN and L. MONHEMIUS. De Ingenieur, 49: W 115–23, 1934. From Chem. Abst., 29: 5207, August 10, 1935. Study of the chemical (dilution) method of determining pump capacities. Large quantity (400 liters) of nearly saturated sodium thiosulfate solution is run into station inlet during short period (1 minute). Outlet water is tested for thiosulfate, sample being obtained from 3 small gear pumps at different elevations; titra-

tions are made with 0.01 normal iodine-potassium iodide solution in 250 cc. volume and compared with known dilutions of thiosulfate with water used. Dilution determined was about 1:5000. Period of some 10 minutes is required to obtain constant titration value in water outlet. For practical purposes, method with short-period additions (shot tests) (STROHMEYER, Proc. Inst. Civ. Eng., 160: 349, 1905; BOUCHER and MALLET, Bull. tech. Suisse romande, 1910, No. 11; VAN ITERSON, Engineering, 1914, 743) can be used. Concentration of reagent in outlet is curve with maximum, characteristics of which are determined by periods t_v and t_e required for fastest and slowest water particle to travel from inlet to outlet. These periods are separately determined by adding oil or fluorescein solution to water and taking set of consecutive outlet samples. Chemical difficulties in method include end point, potassium iodide being added prior to titration, and influence of fen water containing carbon dioxide on thiosulfate solutions. Thiosulfate solution made up with this water was stable for 3 or 4 hours; in first 9 hours, strength increased 1 percent. Water had blank of 1 cc. 0.01 normal iodine, nearly 10 percent of titration value (12 cc.). End point should be obtained for all solutions in about same time and local high iodine concentrations should be avoided in titration. Other experiments were made with copper sulfate as indicator substance and precipitating copper as CuCNS (RIVOT method); this process is too time consuming. Conclusion: STROHMEYER shot method is useful and gives accurate results for brackish waters with thiosulfate instead of original sodium chloride.—*R. E. Thompson.*

Pump Cases, Worn by Silt, Relined with Lead. Eng. News-Rec., 115: 198-9, August 8, 1935. Water supply of Boulder City, Nevada, is derived from Colorado River. Raw water, containing turbidity ranging up to 140,000 p.p.m. and averaging 30,000 p.p.m., is pumped into settling basin and delivered against head of 2,300 feet to treatment plant on edge of town. Under these conditions the wear on pumps, which are rated at 750 g.p.m. against 115-foot head when driven at 1,760 r.p.m., is very great. Pumps are used until cast iron cases become so worn that delivery is only about 65 percent of rated capacity and are then reconditioned. Original cast iron case averages 450 hours of service, after which it is relined with bronze at cost of approximately 95 percent of new case. Bronze lining gives average of 650 hours of service or 44 percent more than cast iron case. When bronze lining is worn down to thickness of about $\frac{1}{8}$ inch, pump is again taken out of service and casing built up by wiping worn places with lead. This lead lining costs about 20 percent as much as new case and gives average service of 410 hours, or 91 percent of average from original case. In wiping the worn bronze casings, if spots are found where bronze has worn through to cast iron, such places are built up with bronze before lead wiping is put on. Soft bronze welding rod is used, and common wiping lead or solder for soft metal finish. Relining with lead can be continued indefinitely.—*R. E. Thompson.*

Automatic Pumping System Eliminates Labor Cost. Eng. News-Rec., 116: 237, February 13, 1936. Recently installed pumping system at North Easton, Mass., is completely automatic except for occasional checking of lubrication.

Diesel engine, in addition to driving pumping unit, supplies heat for station, maintaining temperature of 70°F. Plant consists of 100-h.p., 6-cylinder, 4-cycle engine connected to single-stage centrifugal pump delivering 800 to 1000 gallons per minute against total operating head of 170 feet. Operation cost is equivalent to electric power at less than 4 mils per kw.-hr., purchase price of which was formerly 2.8¢ per kw.-hr.—*R. E. Thompson.*

PIPE

Friction Tests in New Cast Iron Centrifugally Formed Pipe. Eng. News-Rec., **115**: 356, September 12, 1935. Results given of flow tests on transmission system of Six-Town project south of Springfield, Illinois, supplying towns of Chatham, Auburn, Virden, Girard, Pawnee, and Divernon. All pipe was of 150-pound centrifugal cast iron class, in 18-foot lengths, with joints of braided jute and grouting compound. Pipe diameter ranged from 6- to 12-inch and average values of *C* in HAZEN-WILLIAMS formula varied from 134 to 145. High values are attributed to smoother interior and fewer joints.—*R. E. Thompson.*

Casting 72-Inch Concrete Pipe in Sections 24 Feet Long. Eng. News-Rec., **115**: 493–5, October 10, 1935. Brief illustrated description of manufacture and laying of 72-inch reinforced-concrete pipe for outfall of Coney Island sewage plant. Total length is 8,200 feet, of which 1,825 feet is on land. For subaqueous section, pipe was supplied in 24-foot lengths with rubber-gasket joints which could be made watertight by merely pulling together. These are believed to be longest sections ever cast for pipe of this diameter. Wall thickness is 7 inches and each section weighs 22 tons. Land sections were cast in 12-foot lengths. Vibrators were employed in casting pipe, and sections were steam-cured overnight in forms and for 1 day after stripping.—*R. E. Thompson.*

Capacity of Cast Iron Main Sustained by Chloramine Treatment. L. WALTER ACKERMAN. Water Works and Sewerage, **83**: 5, 149, May 1936. A 30-year old, 12-mile, 24-inch, cast iron water main at Utica, N. Y., required biennial cleaning to maintain value of HAZEN-WILLIAMS *C* above 100. Chloramine treatment resulted in suppression of tuberculation with consequent maintenance of high values of *C*.—*H. E. Hudson, Jr.*

Failures in Steel and Cast Iron Mains and Provisions for Their Protection. E. F. REID. Proc. Inst. Civ. Engrs. (London), Eng., Paper **154**, 53 pp., 1934. From Chem. Abst., **29**: 5555, August 20, 1935. Causes of failure may be (*a*) structural defects, e.g., subsidence, faulty joints; (*b*) physical, e.g., frost; (*c*) chemical, e.g., corrosion; or (*d*) electrolytic corrosion. Alkaline water with pH greater than 7 tends to inhibit internal corrosion. Incrustation and tuberculation are not always accompanied by corrosion. Tubercles thrive in iron-bearing water, but colonization is possible only on exposed iron. For new mains, cement- or bitumen-lining overcomes trouble; for existing mains, treatment of water at source is necessary. Valuable information relating to

corrosiveness of soil is derived from knowledge of electric resistivity (r); little corrosion occurs in soil having r greater than 1000 ohms per cc. Methods of protection include embedding in concrete or gravel, painting with lime-impregnated pitch, and galvanizing. Electrolytic corrosion is caused chiefly by stray currents from electric railways; danger from alternating current is slight.—*R. E. Thompson.*

Strength of Hard Lead Pipe. H. BABLIK and J. KRYSTOF. Gas- u. Wasserfach, 78: 279–80, 1935. From Chem. Abst., 29: 4714, July 20, 1935. Calculations are given for bursting strength of lead pipe in terms of antimony content. For water pipes, optimum antimony content is apparently from 0.36 to 0.72 percent.—*R. E. Thompson.*

Bell and Spigot Joints Tested at Ohio State University. Eng. News-Rec., 115: 429, September 26, 1935. Brief data given from Bulletin 87 of Engineering Experiment Station of Ohio State University, by Prof. JOHN C. PRIOR, on failure tests of cast iron pipe to determine bell rupture and pull-out strength. Deflection tests were extended well beyond failure point of each joint. Significant fact developed that broken or cracked bells, due to deflected pipe, would be rare on 20-inch pipe of A. W. W. A. Class *D* standard. Strain diagrams indicated that, if sufficiently strong jointing materials were available to rupture bell, arc would be broken out approximating its upper quarter. Using lead joints, it was found that calking was responsible for one-third to one-half maximum bell strain that joint could sustain. Harder jointing materials like sulfur compounds or portland cement were destroyed before conditions causing maximum strain from deflection were reached. Sulfur compounds and lead were tested for pull-out strength in joints on pipe ranging from 6 to 60 inches in diameter, regulated water pressure being applied to interior of unit. Pressure at which incipient failure may be expected for calked lead joints was found to be expressed by $P = \frac{3800}{D+6} - 40$, in which D is nominal diameter in inches and P, the pressure of contained liquid in pounds per square inch. Formula cannot be used for diameters beyond 60 inches. A few tests on joints made with sulfur compounds indicated that same expression may be used for them. Lead showed distinct flow under load, indicating that joint will sustain temporarily a much larger load than it can carry permanently. There appeared to be no relation between quality of leakage and size of pipe. In nearly every case, failure began by spigot slipping through, or out of, lead. Single long-time experiment with a sulfur-compound joint indicated that strength improves greatly with age; one joint rewaterproofed itself after it had been broken.—*R. E. Thompson.*

METERS AND SERVICE PIPES

"New" Meters from Old. LA VERNE TRENTLAGE. Water Works and Sewerage, 83: 5, 180, May 1936. Advocates cleaning and brightening meters by dipping parts successively in tri-sodium phosphate and in acids. Not only is better cleaning obtained, but brightening favorably impresses consumer.—*H. E. Hudson, Jr.*

Secondary Elements for Water Works and Sewerage Meters. L. D. CARLYON, M.E. Water Works and Sewerage, **83**: 5, 176–180, May 1936. Sequel to earlier paper on primary elements. Explains, with illustrations, open float tube register, pressure chamber register, air meters, and register instruments.—*H. E. Hudson, Jr.*

Meter Testing and Repair. Some Experiences at Louisville, Ky. CLEM. A. GALLAGHER. Water Works and Sewerage, **83**: 4, 107–111, April 1936. Author regards an efficiently conducted metering department as a most valuable asset. The four chief branches are those of meter exchange, testing, repairing, and records. Complete details are given of organization of Louisville meter department and of its smooth and uninterrupted operation. Endurance testing of meters is described.—*H. E. Hudson, Jr.*

Regulating Water Piping Within Buildings. STEPHEN H. TAYLOR. Water Works and Sewerage, **83**: 3, 78–80, March 1936. Surface water supply of New Bedford, Mass., is quite active and rapidly attacks steel, or galvanized iron pipe. In consequence, pressures have often become greatly reduced by tuberculation in consumers' systems. This inconvenience and increasing appreciation of danger of back-siphonage have led to adoption by Water Board of rules and regulations governing installation of house piping, which are given in full. Regulations cover service and connection, all inside piping arrangements (which must be inspected and approved), permissible piping materials, protection against freezing, prohibited cross-connections, and pipe sizes. Resulting benefits have been equally great both to consumer and to distributor.—*H. E. Hudson, Jr.*

Thawing Frozen Water Lines. A. D. CLAGGETTE. The American City, **51**: 9, 69, September 1936. Cost of thawing frozen water mains was reduced 78 per cent at Barberton, Ohio, last winter by using arc welding generator direct connected to second-hand automobile engine. All that was necessary was to connect one lead to the water pipe in one house, the other to the water pipe in the house next door, and start the engine. As many as 39 frozen services were thawed in 24 hours. Water meters were always removed from the line to eliminate all possibility of cross connection with gas lines and melting the lead in gas pipe connections.—*Arthur P. Miller.*

A Quick Method of Making Wet Taps. E. T. CRANCH. Water Works and Sewerage, **83**: 5, 190, May 1936. Suggests use of compressed air motor to drive tapping machine, claiming considerable saving in time.—*H. E. Hudson, Jr.*

RAINFALL, FLOODS AND FLOOD CONTROL

Weather and Water in 1935. Eng. News-Rec., **116**: February 6, 1936. **Weather.** MONTROSE W. HAYES. 223–4. Cooler and wetter weather prevailed in 1935 than in 1934. Temperature was higher than in average year and precipitation for country as whole was not unusual. Answers to several

important questions were provided by observations in 1935. It is frequently asked toward end of long dry period, "Does the end come suddenly, or does it come about gradually." In most instances rainfall increases gradually; but in 1935, in large areas of country a sudden end came to protracted period of drought. Pessimistic view held by some that climate was permanently changing and that some regions formerly well watered would become semi-arid was proved unfounded. There have always been dry trends and wet trends following each other, and probably always will be. Also, several rain storms of unusual severity show, when coupled with similar occurrences in other years, that perhaps no part of United States is free from this phenomenon, but that similar storms are of almost annual occurrence in widely separated parts of country and result from fairly well understood combinations of atmospheric conditions. They are not peculiar to any region, not even the extreme southwest being immune from them, and are rare in any given locality. **Water.** JOHN C. HOYT. 224. After 5 years of widespread droughts, during which previous low records of both streamflow and ground water levels were broken, water supplies during 1935 in most sections of United States approached, or exceeded, normal. Mean annual flow of most streams was average, or above, in all but 7 of the 31 humid states. In the 11 arid states, with exception of California and Washington, flow was somewhat below average: in the 6 semi-arid states, it was above average, except in the Dakotas. There was marked recharge of ground water reservoirs in most states: it was greatest where levels had been most lowered by previous droughts, especially west of Mississippi River, reaching 10 feet in some localities. This indicates that ground water recharge after droughts is probably more rapid than has been believed heretofore. Marked improvement in facilities for river measurement resulted from completion in 1935 of station repair and replacement program made possible by emergency fund allotments. —*R. E. Thompson.*

Frequency of Intense Rainfall in Iowa Analyzed. Eng. News-Rec., 115: 190–1, August 8, 1935. Brief details given from paper presented by F. T. MAVIS and D. L. YARNELL at winter meeting of Iowa Engineering Society. Paper gave summary of analysis of intense rainfall experienced at stations in Iowa for periods ranging from 5 minutes to 6 days, showed empirical relationship between intense monthly and intense 1-day rainfall of same average frequency, and outlined method of correlating rainfall and runoff data which had been suggested by comparison of monthly and 1-day rainfall of given frequency. **Discussion** by MERRILL BERNARD in Eng. News-Rec., 115: 475, October 3, 1935.—*R. E. Thompson.*

Safety Feature in Earth Dam Spillway Tested in New York Flood. WALLACE V. R. FRETTS. Eng. News-Rec., 115: 319, September 5, 1935. July floods in central New York State, which caused destruction of one earth-fill dam of Hornell, N. Y., water reservoir system, direct attention to interesting safety device incorporated in another earth-fill dam of same system, impounding 150 million gallons, approximately 425 feet long at top and 90 feet at bottom, and with height of 75 feet. Reinforced-concrete corewall, reaching

from point 3 feet above top of fill down to solid anchorage in rock, extends horizontally from dam side of spillway across valley and is anchored into opposite side of valley up to point well above possible high-water level. Between shore side of spillway and actual slope of natural valley, corewall was omitted, thereby providing intentional point of weakness, or safety plug, which would not come into play until 8-foot crest had been reached upon spillway. Latter was designed for 5-foot crest with estimated 500-year storm, but will automatically accommodate itself to any flow by tearing out of riprap on shore side, such widening being always in direction away from dam. During flood, flow over spillway weir reached depth of approximately 4.25 feet. Small section of riprap, about 10 feet in length, was washed out. An 8-foot crest over spillway would correspond to flow over double that which actually occurred.—*R. E. Thompson.*

Heavy Rains in Western New York State Cause Worst Flood in Seventy Years. Eng. News-Rec., 115: 65–6, July 11, 1935. Brief details given of flood which reports characterize as worst since 1865. As much as 9 inches of rain fell in several localities in as short a time as 15 hours. Glen Falls reported rainfall of 10.35 inches.—*R. E. Thompson.*

Heavy Rainfall and Floodflows in New York Area. Eng. News-Rec., 115: 161–2, August 1, 1935. Tabulation, compiled from government records, is given, showing in detail rainfall and streamflow data of region affected by storm in July. Five inches, or more, of rain in day was general. Maximum in 24 hours was 8.52 inches, at Delhi: Cortland, with 24-hour precipitation of 7.67 inches, had greatest total rainfall, 11.54 inches.—*R. E. Thompson.*

Record Stream Discharges Feature New York Floods. Eng. News-Rec., 115: 91–4, July 18, 1935. Floods of devastating proportions resulting from scattered cloudburst storms which swept across 7,000 square miles of territory in southern and central New York State on July 7 and 8, doing damage there and in northwestern Pennsylvania in excess of $25,000,000 and causing loss of 55 lives. Rainfall for many locations passed all records. At Hector, 14.23 inches fell in 47 hours, including one downpour of 10 inches in 7 hours. Throughout the area, precipitation of from 1.5 to 2 inches in 24 hours would represent heavy rainfall. Preliminary estimates of river flows made by United States Geological Survey are given in table. Almost entire 1,500 acres of Hornell was inundated. Dam number 1 of city water supply was washed out. Dam number 3, built in 1931, was so designed that 5-foot head on spillway, estimated to be 500-year possibility, would wash out embankment section on shore edge of spillway. This safety device was within 0.75 foot of being called into action. Two cast iron lines carrying water supply from 4 reservoirs to filter plant were broken; while temporary line was being built from hillside spring pond, water from well was delivered by truck to 16,000 residents 4 times daily in milk cans by department of public works. Free inoculation against typhoid was provided by city. Record rainfall of 8.12 inches in 36 hours at no time endangered the 3 dams which serve to store water supply of Ithaca. Filter plant was protected by series of culverts

and, although turbidity increased to 7,000 p.p.m., which was combated by heavy doses of alum, pure and clear water was available at all times. In Binghampton, 3 of 6 water main river crossings were washed out and certain sections of city were without water for 2 days until auxiliary connections were made. In meantime fire broke out in flooded district threatening destruction of entire first ward.—*R. E. Thompson.*

STREAM POLLUTION

Mine-Sealing Program to Reduce Acid Pollution in Streams. Eng. News-Rec., **116**: 42–3, January 9, 1936. With objective of reducing flow of sulfuric acid from abandoned coal mines into streams of Pennsylvania, Ohio, Kentucky, and West Virginia, allotment of $2,500,000 was recently approved to carry on large-scale mine-sealing program under direction of WPA. Total acid discharge from 4-state area was estimated by United States Engineers Corps in 1925 to approximate 3,000,000 tons annually. They concluded that between 40,000 and 50,000 abandoned mines in this area were responsible for not less than 70 percent of pollution. Active and marginal mines account largely for remainder; sewage and industrial wastes making only small contribution to total. Such has been progressive increase in resulting damage, that experts of United States Public Health Service believe the engineers' 1925 estimate of $10,000,000 annually may be only 50 percent of actual loss. Air-sealing, based upon theory that exclusion of air from mines will reduce oxidation of pyrites, has been adopted as most practical means of combating formation of acid. Practice usually followed is to build heavy masonry wall just within mine entrance, sealing it tightly all round, save for portion about 2 feet square at bottom. Water trap is built around outside of this aperture, which permits water to escape freely but prevents access of air. There are numerous variations of this type of seal; but air sealing is basic principle in all. Flooding has been abandoned, because of obvious hazard of break-over into neighboring active mines. When properly sealed, acidity of water escaping is reduced by as much as from 50 to 80 percent in first 60 days. Original acid concentration may run as high as 5,000 p.p.m. free sulfuric acid.—*R. E. Thompson.*

Measures of Natural Oxidation in Polluted Streams. I. The Oxygen Demand Factor. H. W. Streeter. Sewage Works J., **7**: 251–79, 1935. From Chem. Abst., **29**: 5210, August 10, 1935. Several equations are given for progressive biochemical oxygen demand in river flow. Estimation of deoxygenating effect of sewage sludge deposits in natural streams by utilizing biochemical oxygen demand determinations at 2 or more sampling points is discussed. Factors affecting oxidation determinations are considered.—*R. E. Thompson.*

Effects of Industrial (Pulp and Paper Mill) Wastes on Fish. Arch E. Cole and Louis F. Warrick. Sewage Works J., **7**: 280–302, 1935. From Chem. Abst., **29**: 5210, August 10, 1935. Waste sulfite liquor, in concentrations of 1:500 or higher, and, indirectly, wood fibers are harmful to fish. Ozone treatment of wastes to increase oxygen content does not seem promising.—*R. E. Thompson.*

Runoff of 34 Percent Solids After Denudation of Watershed. Eng. News-Rec., 115: 235, August 15, 1935. Devil's Gate Dam, near foothills at westerly edge of Pasadena, was constructed by Los Angeles County Flood Control District in 1920. Total drainage area is 30 square miles, 21.7 miles being largely steep mountainous canyons. Large part of area was covered thickly with bush until fire in July 1934, which denuded 3,550 acres. Some 3 months later, heavy rain fell for 2 days on area; 3.26 and 0.77 inches on first and second day, respectively, being recorded in nearby Pasadena. Silting of reservoir during 14 previous years had amounted to 704 acre-feet, or 1.43 percent of total inflow of 49,174 acre-feet. Runoff from storm was 480 acre-feet and inflow brought into reservoir 145 acre-feet of solids, or 34 percent of total volume. On basis of estimated voids of 40 to 45 percent, net volume would be about 18 percent of runoff.—*R. E. Thompson.*

Chlorination of Shellfish Area Charged to Municipalities. Eng. News-Rec., 115: 356, September 12, 1935. Pollution of tidal flats by sewage from 11 cities and towns in Merrimac Valley led several years ago to construction of chlorination plant on Plum Island for sterilization of water from which clams are harvested. On order from supreme court of Massachusetts, commission has reported on allocation of costs among municipalities responsible for pollution. Allocation is arrived at by taking into consideration water consumption, population, and distance from flats, latter being included owing to effect of natural purification. Example of method used is included.—*R. E. Thompson.*

Chicago Sanitary District Reports on Water Diversion. Eng. News-Rec., 116: 67, January 9, 1936. Sanitary District of Chicago has reported to Supreme Court that, with $58,813,040 allotted to it by PWA, it has been able to comply with Court's order to reduce diversion of water from Lake Michigan to not more than 5,000 second-feet. Report also indicates that construction on sewage disposal program has been progressing with such steadiness that district will be enabled to reduce diversion to 1500 second-feet by December 31, 1938, as ordered by Supreme Court. Thirty-five percent of program has been completed.—*R. E. Thompson.*

Oil Pollution and Refinery Wastes. Report of Committee on Oil Pollution, Conference of State Sanitary Engineers, October, 1934. H. F. Ferguson, et al. Sewage Works J., 7: 104–15, 1935. From Chem. Abst., 29: 4862, July 20, 1935.—*R. E. Thompson.*

WATER TREATMENT—GENERAL

New Filter Plant for Town of Burlington, Ontario. Eng. Contract Record, 50: 599–601, July 24, 1935. Brief illustrated description of 1.5-m.g.d. rapid sand filter plant under construction in town of 4,000 population. Plant will consist of 2 mixing chambers, 2 sedimentation basins, 3 filters, chlorination equipment, and filtered water reservoir. Mixing chambers will be of

spiral flow type, air being introduced in first chamber. Intake in Lake Ontario, 16 inches in diameter, was completed last year. Existing works consist of infiltration basin and chlorination equipment.—*R. E. Thompson.*

A Novel Gravity Filter Plant. W. MARTIN JOHNSON, C. E. Water Works and Sewerage, 83: 5, 143–147, May 1936. Considerations of economy have dictated that elevated filter plant shall be constructed in Lexington, Va. Plant will consist of vertical cylindrical sedimentation tank, with mixing basins and filters built on top at such elevation as to deliver water by gravity through proposed zeolite plant to existing elevated storage. In five-story operating tower will be housed entrance lobby and meter room, chlorinating equipment and laboratory, pipe and valve gallery, filter operating tables and various gages, chemical storage and feed equipment, and wash-water tank. Filtered river water will thus be available to supplement existing spring supply.—*H. E. Hudson, Jr.*

Filters and Meters for Chicago Move Toward Reality. ARTHUR E. GORMAN. Eng. News-Rec., 115: 371–4, September 12, 1935. Enabling acts were approved by Illinois General Assembly in July, permitting sale of $63,000,000 of revenue bonds in period 1936–41 and authorizing Chicago Park District to grant permission for construction of water works structures in park property along lakefront, or in Lake Michigan. Ordinance must now be passed by city council requiring metering of services, formal approval of lakefront sites by park district secured, and permit obtained from War Department and from State for building structures in navigable waters. Favorable action is anticipated. Present plans call for action in South District first, where situation regarding water service and quality is most critical. A 384-m.g.d. filter plant is projected at estimated cost of approximately $20,000,000, to be liquidated with revenue from universal metering and 10 per cent increase in rates. Application has been made to PWA for loan and grant. Industrial, commercial, and other large consumers are metered, but to date, general metering program has been enforced only among domestic consumers whose bills amount to $25 or more per year. Result has been that metered consumers, using about one-third of water pumped, pay about two-thirds of total income of water fund, average non-metered consumer receiving water at less than cost. Experiments have indicated that Lake Michigan water with proper preliminary treatment can be filtered successfully during summer at maximum rate of 4 gallons per square foot per minute when period of operation does not exceed 2 weeks. Maximum rate indicated for winter operation, owing to possibility of floc passing filters, was 2.5 gallons per square foot. On basis of these rates and universal metering, most advantageous size for South District plant would be three 128-million gallon units. Logical location would be within retaining wall in lake near principal existing tunnel with direct intake off lake end of plant. This would avoid costly tunnel construction needed for inland treatment plant and additional head created by filtered water reservoir on existing tunnel would increase capacity of present pumping stations.—*R. E. Thompson.*

SEDIMENTATION

Water Plant Capacity Increased by Modifying Settling Unit. R. F. Goudey. Eng. News-Rec., 115: 370–1, 1935. Inadequate settling capacity limited output of Wilmington rapid sand filter plant, Los Angeles, to 1.5 million gallons per day, although designed for 5 million. Raw water, with color of 28 to 125 p.p.m., is treated with 2 grains per gallon ferric chloride and, after 30-minute mixing period, is settled in a mechanical clarifier and filtered. Low capacity was traced to excessive breakage of floc in passing over weirs, etc., high-velocity currents in tank, and formation of sludge banks in tank corners. If sludge was not removed continuously, α-humic acid, collected by floc, became food supply of bacteria which peptized the floc and allowed iron to pass into final effluent. Modification of the clarifier, principally in inlet and outlet design, together with specially designed corner-cleaning mechanism, increased capacity to 6 million gallons per day, with occasional maximum of 6.75. At 6-million rate, detention period in clarifier is 48 minutes, in which time 80 per cent of the floc is removed. Filter runs average 18 hrs. —*R. E. Thompson* (*Courtesy Chem. Abst.*).

Pre-Treatment with Iron Salt Solves Clarification Problem. E. L. E. Zahm. Water Works and Sewerage, 83: 3, 89, March 1936. Lime-soda-ash-sodium-aluminate treatment at Franklin, Mo., for locomotive boiler feed purposes, failed to clarify impounded surface water containing colloids. Manipulation of order of application of chemicals was unsuccessful; but with preliminary addition of iron sulfate before the other chemicals, problem was instantly solved. Plant effluent is treated with alum and pressure filter and operation of this unit was also improved by use of iron.—*H. E. Hudson, Jr.*

SOFTENING

Automatic Softening and Iron Removal Plant at East Lansing, Mich. Frank R. Theroux. Water Works and Sewerage, 83: 5, 186, May 1936. Water supply containing 327 p.p.m. hardness and 1 p.p.m. iron is being treated by zeolite for complete removal of iron and 75 percent reduction of hardness. Plant is entirely automatic, requiring only periodic inspections to make adjustments and prepare solutions. Three-fourths of water is completely softened by passage through five greensand filters, while remainder is treated by manganese zeolite, to remove only iron. To prevent corrosion, plant effluent is treated with caustic soda and sodium silicate. Iron removal units are periodically automatically reactivated by potassium permanganate; greensand units, by salt solutions. An economical novelty is the recovery of some brine used in reactivation. Chemistry of treatment is explained. Full description of automatic features is given. Cost of treatment totals 5.65 cents per 1,000 gallons.—*H. E. Hudson, Jr.*

Acid Before and After Zeolite. Raymond Davis. Power Plant Eng. 39, 411, 1935. From Chem. Abst., 29: 5207, August 10, 1935. If alkaline water is treated with sulfuric acid before passing through zeolite and not aërated to remove liberated carbon dioxide, there will be little improvement, as

carbonic acid will exchange to produce sodium carbonate as readily as would bicarbonates of calcium and magnesium.—*R. E. Thompson.*

TASTE AND ODOR CONTROL

Activated Carbon, Its Nature and Use. J. WRENCH. Eng. Contract Record, 50: 610, 1935. Brief non-technical discussion. It has been estimated that, in the type of activated carbon used for removing taste and odor from water, there are 120,000,000,000 particles per gram. Over 700 plants on this continent are successfully removing taste and odor with activated carbon.—*R. E. Thompson (Courtesy Chem. Abst.).*

Water Purification in Slow Sand Filters with the Use of Activated Carbon. M. JAENICKE. Gesundh.-Ing., 58: 150–2, 1935. From Chem. Abst., 29: 4858, July 20, 1935. Three experimental filters were used, each of cross section of 80 square centimeters and depth of 70 centimeters. Filter (1) was of sand only, (2) of mixture of 4.0 liters sand and 1.6 liters carbon (Hydraffin K), and (3) of carbon only. Units were operated according to usual method for slow filters, water velocity being about 20 centimeters per hour. Removal of color and organic matter, respectively, were: for (1) 15 and 17 percent, for (2) 80 and 65, and for (3) 90 and 75. Work with 4th unit indicated that as little as 3 grams Hydraffin K per liter of water was sufficient to remove tastes and odors completely.—*R. E. Thompson.*

Taste and Odor Troubles in Bulawayo Water, With Special Reference to the Use of Activated Carbon. A. C. THORNTON. Inst. Civil Engrs. (London) Selected Eng. Paper No. 156, 9 pp. From Chem. Abst., 29: 5553, August 20, 1935. River water is impounded by dam 13 miles away and after coagulation with lime and alum and rapid sand filtration is treated with ammonia-chlorine. Tastes and odors due to algae have been controlled by 1 p.p.m. copper sulfate prior to treatment: in serious cases reservoir has been treated with copper sulfate and bleaching powder (2 pounds of each per 10^6 gallons) and powdered activated carbon fed on to filters, with consequent choking and increase in wash water. It has been found best to add carbon with coagulant, adequate contact being thus provided and the carbon being finally carried down with floc. Efficiencies of carbons have been estimated by amount required to remove hydrogen sulfide from solution containing 0.2 cc. saturated aqueous hydrogen sulfide per liter.—*R. E. Thompson.*

STERILIZATION

Dechlorination of Water. RUDOLF ADLER. Gesundh.-Ing., 58: 272–4, 1935. From Chem. Abst., 29: 5208, August 10, 1935. "Katarsit" a solid preparation of general formula $m\text{CaO}\cdot n\text{CaSO}_3$ may be obtained with high value of ratio m/n when alkaline agent is also needed, or with low value ratio when dechlorination only is required. Following advantages over activated carbon are pointed out: (1) since calcium sulfite has appreciable, although very low solubility, dechlorination is not confined to liquid-solid surface, but also

takes place in solution; (2) since solubility of calcium sulfate formed is about 4 times that of sulfite, surface of latter is continually being renewed; (3) preparation does not, as is case with carbon, adsorb bacteria, etc. and thus become ineffective. (4) increase in dechlorinating action with increased amount of product used is approximately linear; with carbon it is logarithmic. —*R. E. Thompson.*

Electrolytic Cells. DAVID J. EVANS. Brit., 425, 703, March 20, 1935. From Chem. Abst., 29: 5362, August 20, 1935. Cell for chlorination of drinking water or production of bleaching liquor of disinfectants or germicides, e.g., chloramine, comprises closed integral vessel of insulating material containing spaced vertical carbon electrode plates having perforations alternately at top and bottom whereby electrolyte flows through cell in sinuous path. Electrodes are mounted in grooves at sides of cell. Cf. C. A., 28: 1936.—*R. E. Thompson.*

The Significance of the Electro-Katadyn Sterilization Method in the Water Economy of Larger Communities. A. SALMONY-KARSTEN. Städtereinigung, No. 3, 70–3, 1935; Wasser u. Abwasser, 33: 112. From Chem. Abst., 29: 5207, August 10, 1935. Cost of silver used in sterilizing cubic meter of water is about 0.5 Pfennig (0.12 cents). Three installations described.—*R. E. Thompson.*

BOILER FEED WATER

Feed-Water Treatments for Modern Boilers. A. SPLITTGERBER. Z. Ver. deut. Ing., 79: 339–46, 1935. From Chem. Abst., 29: 4494, July 10, 1935. Feed water must be freed as far as possible from insoluble suspended matter, dissolved organic and mineral matter, and gases. High pH values from addition of alkaline reagents protect iron surfaces from corrosion. Boilers operating at high pressures (50 atmospheres and over) may suffer from corrosion by carbonic acid (formed from free carbon dioxide in water), iron attacked forming ferrous carbonate and hydrogen. Feed water for high-pressure boilers should therefore not contain over 10 p.p.m. carbon dioxide. Some sodium carbonate gives off carbon dioxide under operating conditions. Sodium hydroxide and sodium phosphate do not liberate carbon dioxide at high temperatures and remain effective. Dissolved oxygen is also important factor; in boilers operating at 40–50 atmospheres pressure, oxygen content should be under 0.1 p.p.m. A combined thermal-chemical degasifying treatment is recommended. To reduce foaming and priming, suspended and colloidal matter must be removed, sodium hydroxide and phosphate contents must be kept as low as possible, and soda number must not fall below required values (100 to 400 in presence of excess phosphate, or 200 to 1000 in absence of phosphate). Organic colloidal matter, in addition to causing foaming and priming, causes inefficient softening by chemical processes and clogging of filters in zeolite process. These disturbing materials are removed by flocculation with iron or aluminum salts. Oil may be removed by mechanical means or by electrolytic or chemical treatments. When organic and iron-bearing matter is removed, water can be softened at least to 0.1° (German) by base exchange. Softening treatments discussed include: lime-soda,

sodium-hydroxide-soda, lime-sodium-hydroxide, soda, phosphate, and barium. Preheaters of cascade and plate types are described and their operation discussed.—*R. E. Thompson.*

Some Practical Interpretations of Feed Water Tests. CYRUS WM. RICE. Combustion, 6: 8, 29–32, 1935. From Chem. Abst., 29: 5207, August 10, 1935. Author indicates how routine tests for controlling water conditioning may be used to determine condition of boiler, leaky blow-off valves, make-up water, waste through carry-over, boiler rating, excessive blow-down, etc. Stoichiometric calculations are based on salt and alkalinity tests.—*R. E. Thompson.*

The Removal of Oils from Condensed Water with Activated Charcoal. OTAKAR FALLADA. Listy Cukrovar., 53: 168, 1935. From Chem. Abst., 29: 4860, July 20, 1935. Carbo-Norit-Unie has produced inexpensive activated charcoal Hydraffin which removes oils suspended and dissolved in condensed waters. Filters function automatically and require no attention. Adsorption is satisfactory at elevated temperatures, therefore water need not be cooled. The charcoal also adsorbs organic solvents and dyes, but not inorganic salts in form of ions.—*R. E. Thompson.*

The pH Indicator in the Boiler Room. WARREN VIESSNAN. Power Plant Eng., 39: 221–3, 1935. From Chem. Abst., 29: 4495, July 10, 1935. The pH indicator is considered valuable in locating free carbon dioxide, an important factor in power plant corrosion. Relationship between pH, alkalinity, free carbon dioxide, and corrosion is stressed. Indicator is simple and easily used.—*R. E. Thompson.*

Protection of Spare Boilers from Internal Corrosion. HAROLD FARMER. Power Plant Eng., 39: 219–20, 1935. From Chem. Abst., 29: 4496, July 10, 1935. Dry storage is recommended for long periods; lime is used to absorb moisture from air. For shorter periods, minimum alkalinity of 20 grains per gallon should be maintained and air removed by boiling. Reference is made to use of ammonia and sodium dichromate. It is also considered probable that sodium sulfite can be used as oxygen absorbent for long-period storage. —*R. E. Thompson.*

Use of Graphite to Prevent Formation of Boiler Scale. FREITAG. Oberflächentech., 12: 123, 1935. From Chem. Abst., 29: 5207, August 10, 1935. Addition of finest colloidal graphite to boiler water prevents formation of firmly adhering boiler scale; because of surface action of graphite, salts are precipitated as slime which collects on bottom of boiler and is easily removed. Effect is purely physical.—*R. E. Thompson.*

CORROSION

Determining the Necessary Treatment to Prevent Corrosion. P. L. MCLAUGHLIN. Water Works and Sewerage, 83: 3, 81–83, March 1936. Writer's experience with 9 rapid sand filtration plants in West Virginia treating waters

of low alkalinity, undersaturated with calcium carbonate, led him to realize the desirability of remedying this deficiency. By adding lime to filtered water, "chemical balance" may be attained. Quantity of lime required is determined at frequent intervals by test, procedure for which is given in full. Criterion of saturation is pH, correct value depending on alkalinity of water being treated. It is determined by adjusting several portions of sample to various pH values with lime, and then shaking each portion with liberal quantity of pure calcium carbonate. Alkalinity is determined before and after. The pH at which alkalinity does not change during contact with calcium carbonate is that at which water is corrosively neutral. Experience with any given water permits determination of general curve showing relation between alkalinity before corrective treatment and desired pH.—*H. E. Hudson, Jr.*

Influence of Protective Layers on the Life of Metals. FRANK N. SPELLER. Mech. Eng., 57: 355–60, 1935. From Chem. Abst., 29: 5403, August 20, 1935. Prevention of corrosion by isolating metal from destructive environment is discussed under 3 divisions, (*a*) thin films, but few molecules thick; (*b*) metallic and non-metallic coatings of medium thickness; and (*c*) reinforced hot-bituminous, or portland cement mixtures. General discussion includes coatings for underground pipe and their essential requirements.—*R. E. Thompson.*

Control of Corrosion in Air-Conditioning Equipment by Chemical Methods. C. M. STERNE. Proc. Am. Soc. Testing Materials, No. 30, 10 pp. (preprint), 1935. From Chem. Abst., 29: 5402, August 20, 1935. Factors in corrosion of air-conditioning equipment are discussed, the more important being temperature, oxygen concentration, sulfate content, and pH, contaminated air having especially marked effect in decreasing pH. Materials of construction are copper-bearing steel sheet, plain and galvanized, wrought iron, cast iron, bronze spray heads, and variety of metals for condensing units. Because of cost considerations, water treatment is considered only practicable method of combating corrosion in such units. Large number of immersion and spray tests have been made by placing suitable samples in air-conditioning units in actual operation. Following compounds have been tried as inhibitors: sodium dichromate, sodium dichromate and sodium silicate, sodium silicate, sodium carbonate, sodium hydroxide, tannin, and trisodium phosphate. Simple alkali treatments and the phosphate cause pitting. Sodium silicate concentrations of 500 p.p.m. give excellent corrosion protection by film formation but this treatment is unsatisfactory owing to plugging of condenser tubing and diminishing of air capacity. Sodium dichromate, alone or with sodium hydroxide, is most satisfactory inhibitor, giving adequate protection up to 4 years and eliminating organic odors from wash water.—*R. E. Thompson.*

Uniform Corrosion Tests for Pipes. K. ADLOFF. Wärme, 58: 286–9, 1935. From Chem. Abst., 29: 5401, August 20, 1935. Discussion of evaluation of protective effect of coating materials on ferrous pipe buried under ground and subjected to stray-current electrolysis. Effect of soil pH on breakdown of pipe coating materials and values of accelerated and short-time service

tests are reviewed and are considered as an evaluation of test variables such as water absorption, elasticity, conductivity, and aging characteristics of coatings. Curve is shown which evaluates 3 different ferrous pipe materials on uniform basis of number of days required for same coating on all pipes to break down sufficiently to allow current to flow to extent (as shown by previous tests) necessary to initiate corrosion in bare metal. Absorption of water by coating is considered principal cause of breakdown and corrosion of pipe, because of increased conductivity of coating. Several coatings are tabulated according to uniform test procedure and behavior of ideal coating is indicated from curve. Slope of curve is determined from original moisture of coating in relation to tendency to absorb water.—*R. E. Thompson.*

Continuous-Flow Corrosion Tests of Steel Pipe. H. S. RAWDON and L. J. WALDRON. Proc. Am. Soc. Testing Materials, No. 28, 9 pp. (preprint), 1935. From Chem. Abst., **29**: 5402, August 20, 1935. New short-time service corrosion test for ferrous materials in pipe form has been developed at Bureau of Standards. Short lengths of pipe are connected end to end by non-conducting gasket and erected vertically. Solution used for testing sections is allowed to run through by gravity from tank, pump being used for recirculation. Some make-up water is added continually in such amounts that complete change of water is effected every 24 hours. Two open-hearth steels (0.30 and 0.12 percent copper) were tested with Washington city water, hard and softened. Corrosion rate in such pipe assembly varied decidedly according to conditions of flow, maximum rate being at inlet and for low velocities. There was no real difference in corrosion rates of the 2 steels. Deposition of scale simultaneously with corrosion has marked effect on distribution of corrosion.—*R. E. Thompson.*

Use of Inhibitors in Preventing Corrosion by Acids. I. V. A. WARDELL. Chem. Eng. Mining Rev., **27**: 286–90, 1935. From Chem. Abst., **29**: 5401, August 20, 1935. Inhibitors are listed as follows: glue, gelatin, etc., starch, yeast, pyridine, quinoline, naphthalene, sulfuric acid, anthracene oils, glycerine, aldehydes, hydroxylamine, alcohols, ketones, sulfite pulp liquor, tri-thioformate, carbon bisulfide, derivative of reaction product of an aldehyde and a guanidine and a thiourea compound, arsenic, antimony, stannous chloride, and sodium chloride. Effectiveness of sodium chloride as inhibitor can be invoked in describing cause of inhibition (generally regarded as adsorption mode of action).—*R. E. Thompson.*

The (Chemical) Properties of Water and Their Influence on Corrosion. E. NAUMANN. Heizung u. Lüftung, 1934, 89–96; Wasser u. Abwasser, **33**: 110–11, 1935. From Chem. Abst., **29**: 5207, August 10, 1935. Chemical and physical factors most important in determining corrosion are $Ca:CO_3$ ratio, pH, dissolved oxygen, temperature, working pressure, and contact time.—*R. E. Thompson.*

HEALTH AND HYGIENE

Public Health Aspects of Wading Pools for Children. W. J. MCCORMICK. Can. Pub. Health Jour., **26**: 26–32, 1935. Data secured by means of ques-

tionnaire sent to numerous leading cities in U. S. and Canada show that general sanitary practice pertaining to wading pools is confined to more or less frequent changing of water. In only 4 cities, is chlorination attempted. Bacteriological examination of water in wading pools in Toronto showed the water to be polluted in many cases, particularly in pools where bathing suits are permitted and the children allowed to submerge. It is recommended that wading pools be subjected to the same regulations, including filtration and chlorination of the water and provision of sanitary facilities, as swimming pools, and that pools not so equipped should be rigidly restricted to wading. —*R. E. Thompson* (*Courtesy Chem. Abst.*).

Contributions to the Laboratory Diagnosis of Amoebiasis from the Chicago Outbreak of 1933. FRED O. TONNEY, MARIAN MCILHENNY, GERALD L. HOEFT and C. H. KOONZ. Can. Pub. Health J., **26**: 335–48, 1935. Technic for examination of feces, developed as result of Chicago epidemic, is discussed in detail. Essential diagnostic characteristics of *Endamoeba histolytica*, *Endamoeba coli*, *Endolimax nana*, *Iodamoeba bütschlii*, *Dientamoeba fragilis* and *Endamoeba gingivalis*, all of which should be looked for in specimens from the human intestine, are described and illustrated, together with other parasitic forms, in 18 plates.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Amoebic Dysentery: Its Public Health Significance and Control. A. BOLDUC. Can. Pub. Health J., **26**: 215–24, 1935. General discussion, including life history, morphology, and viability of the causative organism, *Endamoeba histolytica*; mode of infection, laboratory procedure and control of the disease. Cysts, the infective form of the parasite, may live for months in water. Thermal death point is 68° for 5 minutes, and desiccation at room temperature will destroy them within 10 minutes. Filtration is as effective in eliminating cysts as bacteria. Cysts are very resistant to chemical disinfectants. Free chlorine at concentration of 500 p.p.m. will destroy them, but only after 10 minutes contact. Cresol is the most effective destructive agent, 1:20 concentration killing cysts almost instantly. Seven references.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

LABORATORY METHODS—BACTERIOLOGICAL

Indole Formation by Escherichia Coli. I. The Breakdown of Tryptophan by Washed Suspensions of Escherichia Coli. DONALD D. WOODS. Biochem. J., **29**: 640–8, 1935. From Chem. Abst., **29**: 5475, August 20, 1935. With continuous aëration, washed suspensions of *Es. coli* gave quantitative yield of indole (I) from tryptophan (II) at 37° in from 16 to 36 hours, depending on degree of aëration. Reaction required 5 atoms of oxygen. Rate of disappearance of II was equal to rate of formation of I. The *d*-form of II was not oxidized by *Es. coli*. Under anaërobic conditions, 1-indolepropionic acid was formed. **II. The Action of Washed Suspensions of Escherichia Coli on Indole Derivatives.** Ibid., 649–55. Indole (I) was not formed by *Es. coli* from following β-indole derivatives: aldehyde, carboxylic acid, acetic acid, propionic acid, and acrylic acid. β-Indolepyruvic acid in presence of ammonia gave rise to I (10 percent production).—*R. E. Thompson.*

A New Method of Bacteriological Analysis of Water. R. ZEETTI. Boll. soc. intern. microbiol., Sez. ital., 7: 164–70, 1935. From Chem. Abst., 29: 5557, August 20, 1935. Following method of RASUMOV (Microbiologia (in Russian), I, 2, 1932) was applied to water: thin cellulose membrane is employed in filtration of water and then placed on solid medium in Petri dish, with surface which was in contact with water turned up. During period in thermostat, bacteria on cellulose membrane grow in colonies, as they would on underlying medium. After growth of bacteria, membrane is examined microscopically.—*R. E. Thompson.*

Isolation of Typhoid and Paratyphoid Bacteria from Water. J. SZPER. Compt. rend. soc. biol., 118: 1675–7, 1935. From Chem. Abst., 29: 4792, July 20, 1935. Modified MÜLLER-KAUFFMANN medium, containing sodium tetrathionate, potassium iodide, and brilliant green, is used. **Mechanism of the Action of Sodium Tetrathionate on the Development of Typhoid and Paratyphoid Bacteria.** Ibid., 1677–9.—*R. E. Thompson.*

A Rapid Method for the Bacterial Examination and Control of Drinking Water. J. GRATCH. Igiene moderna, 1934, 303–6; Wasser u. Abwasser, 33: 128, 1935. From Chem. Abst., 29: 5206, August 10, 1935. Modification of methylene blue reductase test is used to determine quality of water.—*R. E. Thompson.*

A Biochemical Study of the Fermentation of Rare Sugars by Members of the Colon and Aërogenes Groups of Bacteria. II. Cellobiose. CHARLES F. POE and DOROTHEA E. KLEMME. J. Biol. Chem., 109: 43–6, 1935; cf. C. A., 27: 3027. From Chem. Abst., 29: 4403, July 10, 1935. Ratio of carbon dioxide to hydrogen was from 0.3 to 0.5 in gas produced from cellobiose by Escherichia strains. With Aerobacter and A. Cloacae, ratio was close to 0.7. Cellose-negative strains of Escherichia which produced no gas did not ferment all cellobiose in 0.1 to 1.0 percent solution in 72 hours at 37°. Those which formed gas and the Aerobacter strains fermented it completely under same conditions. With both groups of organisms in medium containing 0.1 percent sugar, pH values reached minimum in about 12 hours and then increased to maximum of about 8.5. Minimum was lower in medium containing 0.5 percent sugar. Minimum for cellose-negative organisms was not as low as for cellose-positive. Though difference in amounts of products formed by the 2 groups was slight, Aerobacter formed somewhat more succinic and lactic acids than did Escherichia.—*R. E. Thompson.*

Bacteriostatic and Bactericidal Studies of Various Dyes and Allied Compounds. S. A. PETROFF and WM. S. GUMP. J. Lab. Clin. Med., 20: 689–98, 1935. From Chem. Abst., 29: 4402, July 10, 1935. Of 130 compounds studied, the azine, oxazine, thiazine, and basic triphenylmethane dyes, anil quinoline derivatives, and a few alkaloids and their derivatives were found to be effective bactericidally and bacteriostatically for Gram-positive organisms. Anil quinoline derivatives were most effective for Gram-negative organisms, triphenylmethane dyes being moderately effective and acridine dyes slightly active.—*R. E. Thompson.*

The Change of Colon Bacteria Caused by Retention in Water for Lengthy Periods. R. FRADKINA and S. CHAIT. J. Mikrobiol. u. Immunobiol.; Wasser u. Abwasser, 33: 159, 1935. From Chem. Abst., 29: 5208, August 10, 1935. Es. coli kept in flowing filtered water changed in type to organism resembling *Bact. fecalis alcaligenes*, Aerobacter aerogenes, and *Bact. anindolicum*.—*R. E. Thompson.*

LABORATORY METHODS—CHEMICAL

The Occurrence and Determination of Manganese in Sea Water. THOMAS G. THOMPSON and THOMAS L. WILSON. J. Am. Chem. Soc., 57: 233–6, 1935. From Chem. Abst., 29: 5376, August 20, 1935. Modification of method of WILLARD and GREATHOUSE (C. A., 11: 3189) was developed for colorimetric determination of manganese in sea water and bottom mud. Manganese content of filtered sea water varied from 0.2 to 1.8 $\times$ 10^{-4} milligram atoms manganese per kilogram of water. Method detects variations of 0.18 — 10^{-4} milligram atoms manganese. Plankton ash contained 0.07 percent manganese; waters rich in plankton were low in dissolved manganese.—*R. E. Thompson.*

Determination of Chlorides by Titration with Silver Nitrate, Bromophenol Blue and Starch. M. ARCHAMBAULT. Can. Chem. Met., 19: 126, 1935. From Chem. Abst., 29: 5378, August 20, 1935. Modification of MOHR volumetric determination of chlorides in presence of potassium chromate involves use of adsorption indicator (bromophenol blue) after preliminary treatment with corrective solution (barium nitrate) followed by addition of diffusing liquid (starch). Procedure: Use sufficient barium nitrate to precipitate most of interfering elements, make neutral to methyl orange, add 5 drops 1 percent indicator solution per 100 cc. solution and 5 drops saturated starch containing 0.12 percent salicylic acid, and titrate with 0.1 normal silver nitrate to first tinge of mauve.—*R. E. Thompson.*

A Comparison of Winkler's and Alsterberg's Methods for the Determination of Oxygen in River Water and Sea Water and Some Experiments with Distilled Water. H. PILWAT. Angew. Chem., 48: 338–9, 1935. From Chem. Abst., 29: 5557, August 20, 1935. WINKLER method is always to be preferred for sea water, when interfering substances are absent. For fresh waters, not too greatly contaminated, both are equally applicable. WINKLER method might be preferable, as it is easier to manipulate and gives better checks. For waters strongly contaminated with sewage, ALSTERBERG method might be preferable, but this was not established by experiments.—*R. E. Thompson.*

Determination of Traces of Lead in Drinking Water. J. F. REITH and J. DE BEUS. Chem. Weekblad, 32: 205–10, 1935. From Chem. Abst., 29: 4206, August 10, 1935. Causes of errors in WINKLER colorimetric lead determination, such as iron, organic coloring matter, copper, manganese, aluminum, etc., are discussed. Absorption of lead by calcium carbonate was studied at different alkalinities; it is only quantitative if solution is very

weakly alkaline to phenolphthalein. Colorimetry of solutions was tested by shielded 40-watt blue glass cylindrical lamp. All samples had 5 cc. 4-normal hydrochloric acid per liter. Three methods are given. (1) For water of less 10 p.p.m. ferric iron and no organic color (less than equivalent of 10γ lead). Add to 80 cc. water (containing 0.4 cc. 4 normal hydrochloric acid) 4 drops 10 percent potassium cyanide, 10 cc. 20 percent sodium potassium tartrate, 10 cc. ammoniacal (2-normal) ammonium chloride (20 percent) while mixing. Compare color with lead standards containing varying amounts of lead, 80 cc. water, 0.4 cc. 4-normal hydrochloric acid, 4 drops potassium cyanide solution, 10 cc. potassium sodium tartrate solution, 10 cc. ammoniacal ammonium chloride solution, and 2 drops sodium sulfide (10 grams $Na_2S \cdot 9H_2O$ in 25 cc. water made up to 100 cc. with glycerol). Standard lead solution consists of 160 milligrams lead nitrate — 4 cc. 5 normal acetic acid to 1 liter; 1 cc. = 0.1 milligram lead. After making first color control, (B), add 2 drops sodium sulfide solution to unknown and measure color (E) within 10 minutes. Lead content of water is $E - B$. (2) For water of less than 10 p.p.m. ferric iron, but with yellow organic color: Boil down 100 cc. water containing 0.5 cc. 4-normal hydrochloric acid to 50 cc. in 200-cc. Erlenmeyer flask after adding 5 cc. 5 percent ammonium persulfate. Cool to 50°, add 4 drops potassium cyanide solution, 10 cc. potassium sodium tartrate solution, and shake for few minutes. If solution is clear, add 10 cc. ammoniacal ammonium chloride and make up to 100 cc. in colorimeter. If solution is turbid, filter into colorimeter on top of ammonium chloride and wash filter with 0.1 normal hydrochloric acid. After cooling, determine initial color, B, add 2 drops sodium sulfide solution and determine E. Lead content is $E - B - R$, R being blank of reagents. (3) For all types of water, by concentration of lead on calcium carbonate (run blank with pure water for each determination). Add to 1 liter water (or equivalent of 50–100γ lead) containing 5 cc. 4-normal hydrochloric acid, 5 cc. potassium cyanide solution and 3 drops phenolphthalein (1 percent in alcohol). While shaking, make solution permanently, but very weakly, alkaline with 4-normal alkali; add 500 milligram calcium carbonate and shake occasionally for 1 hour. Allow to settle for few hours, decant and filter through 5-centimeter Buchner funnel, wash 4 times with 25 cc. water also weakly alkaline, rejecting filtrate and washings. Dissolve calcium carbonate from filter by boiling mixture of 5 cc. 4-normal hydrochloric acid and 40 cc. water; to filtrate obtained add 5 cc. ammonium persulfate solution and boil down to 80–90 cc. in 20 minutes. After adding 100 milligrams hydrazine hydrochloride (for ferric), boil down for 5–10 minutes to colorless and to 70–80 cc. and cool. Then determine B in colorimeter, using lead solution + 2.5 cc. 4-normal hydrochloric acid + 10 cc. ammonium chloride-ammonium acetate solution (15 and 20 percent, respectively) made up to 100 cc. + 2 drops sodium sulfide solution as standards. Make actual determination by adding mixture of 10 cc. ammonium chloride-ammonium acetate solution and 2 drops sodium sulfide to unknown (this should then be neutral to Congo red). Determine E; lead content is $E—B—R$. Lead sulfide color should disappear on adding 10 cc. 4-normal hydrochloric acid to colorimeter contents. Number of check analyses are given.—*R. E. Thompson.*

Determination of Traces of Cyanides in Water. A. E. CHILDS and W. C. BALL. Analyst, 60: 294–9, 1935. From Chem. Abst., 29: 4860, July 20, 1935. Add excess tartaric acid to 500 cc. filtered water, distil off 50 cc. and test distillate by Prussian blue test if hydrocyanic acid content is not less than 4 p.p.m. Thiocyanate test is more sensitive, but somewhat more tedious. For detecting 0.2 p.p.m. or less, phenolphthalein and silver nitrate tests are suitable. Former depends on production of red color by oxidation in cold of an alkaline solution of phenolphthalin to phenolphthalein in presence of cyanide and weak solution of Cu^{++}. Test is not specific, other compounds causing same oxidation. Silver cyanide test depends on opalescence produced on adding excess silver nitrate to slightly acid solution of cyanide and is also by no means specific.—*R. E. Thompson.*

Determination of Chlorine in Water. H. IVEKOVIĆ. Archiv. Hem. Farm., 8: 185–91 (in German 191–2), 1934. From Chem. Abst., 29: 5208, August 10, 1935. Methods are discussed on basis of current literature and method of FROBOESE (C. A., 15: 913) modified by KAESS (C. A., 28: 2818) is recommended. Relation of chlorine number to permanganate consumption does not show fecal contamination of water, but presence of protein decomposition products which may be of plant or fecal origin. Nature of organic substance in water can be ascertained only by combination of chlorine analysis with results of other analyses.—*R. E. Thompson.*

Colorimetric Determination of Aluminum with Eriochrome Cyanine. II. F. ALTEN, B. WANDROWSKI and E. HILLE. Angew. Chem., 48: 273–5, 1935; cf. C. A., 28: 2294. From Chem. Abst., 29: 5037, August 10, 1935. Influence of other elements on determination was investigated and methods for elimination of interfering substances devised. Experimental data are given for determination of aluminum in amounts as low as 10γ in presence of phosphate, iron, and manganese. Procedure described in detail.—*R. E. Thompson.*

A Method for Determining the Amount of Oxygen Dissolved in One cc. of Water. L. VAN DAM. J. Exptl. Biol., 12: 80–5, 1935. From Chem. Abst., 29: 4491, July 10, 1935. Sample is drawn by means of modified KROGH and KEYS syringe pipet and WINKLER reagents are added without exposing sample to air. Only 1 cc. water is required for each determination and water of very low or very high oxygen content can be analyzed accurately.—*R. E. Thompson.*

Apparent (Absorption) of Oxygen from Permanganate by Distilled Water. A. FISHER. J. Proc. Inst. Sewage Purif., No. 1, 54–7, 1935. From Chem. Abst., 29: 4489, July 10, 1935. In 4-hour oxygen absorption test, dilution and rise in temperature of incubation of N/80 potassium permanganate cause decrease in its "oxygen value," partly because of instability of dilute solution at higher temperatures.—*R. E. Thompson.*

Colorimetric Determination of Traces of Copper with the Sodium Salt of Diethyldithiocarbamate. E. Laget. Ann. chim. anal. chim. appl., 17: 145–7,

1935. From Chem. Abst., 29: 4286, July 10, 1935. In absence of interfering substances, treat 5-cc. sample with 5 cc. 95 percent alcohol and 1 cc. 1 percent solution of reagent in 95 percent alcohol. Brownish yellow color will serve to determine 0.1γ to 0.1 milligram copper. If zinc is present, mix 10 cc. ammonium hydroxide (density 0.880) and 15 cc. 95 percent alcohol and add 5 cc. solution to be tested and 1 cc. reagent. In presence of cadmium, increase ammonium hydroxide to 12 cc.—*R. E. Thompson.*

New Methods in Water Analysis. II. H. F. KUISEL. Helv. Chim. Acta, 18: 332–43, 1935. From Chem. Abst., 29: 5557, August 20, 1935. Sulfate is determined volumetrically by precipitation as benzidine sulfate, filtration, and titration with standard potassium hydroxide. Phosphate ion, with molybdic acid and reducing agent, under certain conditions gives blue complex compound which can be measured colorimetrically. Calcium is precipitated as oxalate and titrated with permanganate. Reagent and procedures described.—*R. E. Thompson.*

LABORATORY METHODS—MISCELLANEOUS

Estimation of Common Fresh Water Plankton. D. H. MATHESON. Can. Pub. Health J., 26: 244–7, 1935. Plankton may be estimated with sufficient accuracy for correlation with water purification plant operation by passing a large volume of water (1000 l.) through 100- and 200-mesh brass screens in series. After washing the catch from the screens, it can be estimated by drying and weighing, or by sedimentation in a graduated cylinder. Results obtained by this method with Lake Ontario water at Hamilton, Ont., are shown graphically plotted against temperature, showing that the plankton, in mg. per cubic meter, increase from less than 100 in early spring, when water is cold, to maximum exceeding 1000 at about 50°F. and decrease to approximately 200 at 70°F.—*R. E. Thompson (Courtesy Chem. Abst.).*

The Investigation of Well Water by Means of the Tyndall Effect. MAXIMILIAN KNORR. Arch. Hyg. Bakt., 113: 274–8, 1935. From Chem. Abst., 29: 5556, August 20, 1935. Changes in composition of well water due to influx of surface water can be determined by means of TYNDALL effect. Method may determine changes in chemical composition and in bacterial count.—*R. E. Thompson.*

Inexpensive Laboratory Flocculator. G. R. FRITH. Water Works and Sewerage, 83: 4, 139, April 1936. Paddles are agitated by means of crank mechanism driven by automobile windshield wiper.—*H. E. Hudson, Jr.*